Implications for ANSI Standard

The rats in Guy's experiment were exposed to an SAR of 0.4 W/Kg, precisely the SAR level specified by ANSI as safe. "Whole body SARs below 4 W/Kg were not by consensus associated with effects that demonstrably constitute a hazard," the ANSI committee wrote in 1982. A safety margin of ten was then factored in. The frequency dependent exposure guidelines, 1 mW/cm^2 in the 30-300 MHz band, stem from the 0.4 W/Kg level.

More than one of the representatives from the federal agencies who attended the Kunz-Guy meeting noted that the new cancer results, if confirmed, would undermine the adequacy of the ANSI standard.

Past Cancer Studies

While Guy's experiment is certainly the most ambitious study, it is not the first to find a connection between cancer and microwaves. The issue has been and continues to be quite controversial, at least in part because there are so few studies in the bioeffects literature.

As Dr. William Kirk wrote in EPA's soon-to-be-released *Biological Effects of Radiofrequency Radiation*, "Because few RF radiation studies in man or animals have employed life span or cancer as end points and none has had sufficient statistical power and adequate quality control...the questions of RF radiation carcinogenesis or life shortening are still open. None of the complete reports in the literature presents a convincing case for the existence of a significantly increased risk of cancer induction...The data of Szmigielski *et al.*, however, raise the possibility that RF radiation may act as a cancer promoter..."

Szmigielski and co-workers at the Center for Radiobiology and Radioprotection in Warsaw have shown that microwaves can promote cancer: 2450 MHz radiation is a co-carcinogen with benzopyrene (*Bioelectromagnetics, 3,* 179, 1982). They discovered that microwaves accelerated the development of spontaneous and chemically induced tumors in mice. The Polish group concluded that, "It remains an open question as to whether the tumor-accelerating effect observed in mice exposed to MW fields at 5 mW/cm^2 is due to specific interaction of the radiation at the cellular or subcellular level...or to a nonspecific stress and/or adaptation reaction."

The other major paper in the microwave-cancer literature was published in 1962 by Susan Prausnitz and Dr. Charles Susskind of the University of California, Berkeley. They irradiated mice with pulsed 9.27 GHz microwaves (2 microsecond pulses, 500 pulses per second) for four and half minutes a day for 59 weeks at a level of 100 mW/cm^2 and found an indication of leukemia — an increase in neoplasms of the white blood cells (*IRE Transactions on Bio-Medical Electronics, 9,* 104, April 1962). In a 1976 review, the Food and Drug Administration called this experiment "the most discomfiting finding in the available literature." Nevertheless, no attempt has ever been made to replicate the Prausnitz-Susskind study.

Epidemiological Studies

A number of epidemiological studies have suggested a link between microwaves and cancer, though none are considered reliable.

• Dr. William Morton of the University of Oregon in Portland has correlated the incidence of leukemia with extremely low (nanowatt) levels of broadcast radiation (see *MWN,* December 1983). EPA, which funded the study, faulted Morton's analysis and refused to publish his report.

• Drs. John Lester and Dennis Moore of the University of Kansas School of Medicine in Wichita uncovered a pattern of cancer incidence which appeared to be related to exposure to radar radiation, though they warned that the relationship was not strong enough to establish a correlation between the two (see *Journal of Bioelectricity, 1,* 59, 1982 and *MWN,* July/August 1982).

• The 1978 epidemiological study of Americans stationed at the U.S. embassy in Moscow uncovered a relatively high proportion of cancer deaths among female employees. Dr. Abraham Lilienfeld of Johns Hopkins University in Baltimore, MD, the study director, noted that there was also an anomalously high incidence of cancer among women stationed in other U.S. embassies in Eastern Europe who served as controls. Lilienfeld could not explain this finding, but hesitated placing too much importance on it because of the small sample size and the long latency periods associated with cancer induction. The microwave exposures at the embassy in Moscow were very low, in the microwatt range.

In addition, over the last few years there have been eight papers linking leukemia to extremely low frequency (ELF) electromagnetic fields (see *MWN,* March and June 1983). The current consensus among researchers is that the biological action by ELF radiation involves a different mechanism than higher frequency radiation such as microwaves — though the distinction may be blurred when microwaves are modulated at ELF frequencies.

Cancer Clusters in the Workplace

There have been at least two clusters of cancer among workers exposed to microwaves on the job. In each case, the ensuing investigations were inconclusive.

• In 1980, workers at the Communications Workers of America Local No. 4354 in Ragersville, OH, reported that five out of eight members of its AT&T Long Lines Depart-

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ment had developed cancer since 1971. NIOSH was called in to study the cluster, but investigators decided that it was an accidental grouping, unrelated to microwaves (see *MWN*, February 1981).

• Also in 1980, the United Paperworkers International Union disclosed a cluster of nine cancer cases among twenty women working on RF sealers at the Beaverite Products Plant in Beaver Falls, NY. NIOSH was again called in but could only identify six cancer cases. The agency did find that the women were exposed to radiation levels far in excess of the then current 10 mW/cm^2 standard. NIOSH decided to terminate the study, because as epidemiologist Terry Leet explained to the union, "There is no convincing evidence in the scientific literature to indicate that RF radiation causes cancer in humans or animals" (see *MWN*, November 1981). NIOSH has been trying to set up an epidemiological study of RF sealer operators for nearly ten years without success.

In the mid-1970's, two radar repairmen at the Naval Air Station at Quonset Point, RI, developed pancreatic cancer and endocrine disorders (the pancreas is part of the endocrine system). One of them, Robert Engell, charged that his condition stemmed from working with Tactical Air Navigation (TACAN) systems and filed a $4.5 million suit against ITT, Raytheon, General Dynamics, Varian Associates and Rockwell International. The suit was settled out of court under the stipulation that the amount of the settlement remain confidential (see *MWN*, November 1982 and January/February 1983). The issue of causality was never addressed in court.

1978 NIOSH Study

In 1978, NIOSH released a literature review of the carcinogenic properties of RF/MW radiation (*Carcinogenic Properties of Ionizing and Non-Ionizing Radiation: Volume II –Microwave and Radiofrequency Radiation*, March 1978). That study found that there was almost no information in the scientific and medical literature.

NIOSH argued in favor of a hypothesis proposed by Dr. Milton Zaret that an increase in cardiovascular disease and an "alleged" rise in cancer incidence in North Karelia, Finland, could be attributed to nearby high-power, Soviet radars (*Medical Research Engineering, 12* 13, 1976). In his analysis, EPA's Kirk discounts this theory as a "misunderstanding/misinterpretation," noting that a Finnish government spokesman has denied any knowledge of increased cancer in North Karelia or of any other microwave-related effect. ●

UPDATES

COMPATIBILITY & INTERFERENCE

ARRL v. Cable TV... The FCC has denied the American Radio Relay League's (ARRL) petition to bar cable television operators from frequencies used by the Amateur Radio Service. Calling the league's proposed solution to interference problems "excessive," the commission ruled that disputes can be solved through cooperation, as demonstrated by the joint special committee (of ARRL, the National Cable Television Association and FCC staff representatives) set up since the petition was filed in 1982 (see *MWN*, October 1983 and March 1984). As outlined in the commission's June 15 decision (No. 84-283 on RM-4040), the league claimed that severe interference, particularly on cable TV Channel E at 144-150 MHz, was "a direct result of cable TV systems using inadequate shielding, low quality components, poor cable installation techniques and inadequate maintenance." While noting "it is clearly the responsibility of the CATV system operator to solve such interference problems," the commission concluded there is "no justification in the record to preclude frequencies" from cable TV use.

RFI-Free Satcom Sites... Spectrum Planning Inc. has come up with a simple way for finding interference-free sites for C-band satellite earth stations. The company's new Pocket Map system can identify locations which are free of RFI from and to 4 and 6 GHz terrestrial microwave systems. Spurious 4 GHz radiation can degrade the operation of satcom receivers, while 6 GHz signals from uplink facilities can in turn interfere with microwave receivers. The Pocket Map system factors in the transmit power, antenna discrimination, antenna centerline and transmission line loss of the terrestrial station with the gain and sidelobe of a standard earth station antenna to find acceptable sites. The technique, which also takes into account predicted propagation losses due to variations in terrain, produces maps which can be placed over USGS regional maps. For more information, contact Spectrum Planning's Randall Oster, 1850 N. Greenville Ave., Richardson, TX 75081, (214) 699-3536.

LITIGATION

Burgis Case Settled... Former Army radar technician Stanley Burgis settled his suit against Western Electric (now AT&T Technologies Inc.) for an undisclosed sum on July 18 (see *MWN*, December 1982). Burgis claimed that radiation from M-33 radar caused cataracts and retina damage. According to Burgis's attorney Gerald McHugh Jr., at the Philadelphia firm of Litvin, Blumberg, Matusow & Young, a condition of settlement is that the terms remain completely confidential. Although McHugh refused to comment on the settlement, a source familiar with the proceedings told *Microwave News* that it was "very substantial." McHugh estimated that his client was periodically exposed to over 40 mW/cm^2 and routinely exposed to 5 to 10 mW/cm^2 during the nine months he worked on the M-33 radar in the early 1950's. These estimates were based on Army and Air Force hazard surveys of other Western Electric M-33 radars. The

case, filed in 1980 before the US District Court for Eastern Pennsylvania in Philadelphia, was scheduled to come to trial on July 31.

EBI Patent Suit... Electro-Biology Inc. (EBI) is seeking over $16 million from the manufacturer and marketers of a bone regenerating system it claims uses the same pulsed electromagnetic fields (PEMFs) as the EBI Bi-Osteogen unit. In a complaint filed in the US District Court for the Northern District of Texas on April 25, the Fairfield, NJ, company charged American Medical Electronics Inc. (AME) and its independent sales representatives with patent infringement and false representation of their product. AME, based in Dallas, TX, has answered the charges, and the case is now in discovery. EBI Vice President Richard Reisner told *Microwave News* that "signal specificity is key" to the effectiveness of the Bi-Osteogen system's non-invasive treatment of hard-to-heal fractures. He noted that, although it is possible that other signals might prove effective, EBI believes that the signal used in AME's Physio-Stim (for humans) and Thorough-Stim (for horses) units is the same as the Bi-Osteogen's. (There is no scientific consensus on how important signal characteristics are in achieving an effect.) Late last year, EBI concluded a successful defense against patent infringement claims from a subsidiary of Canada's Inco Ltd. (see *MWN*, December 1983).

MEASUREMENT

Magnetic Fields from Household Appliances... The IIT Research Institute (IITRI) of Chicago, IL, has completed the most detailed survey to date of magnetic fields from household appliances. Worst case measurements on 100 different appliances of 25 basic types by IITRI's J.R. Gauger found that 95 percent of the maximum magnetic fields at a distance of 1 foot (ft) were below 100 milligauss (mG) and below 1 mG at 5 ft. The maximum value at 5 ft was 4.7 mG. Small appliances with light motors in lightweight casings produced stronger fields than large appliances where the motor is often well shielded. For example, the maximum reading 1 ft from a can opener was 270 mG, dropping to 1.9 mG at 5 ft, while the maximum readings for a dishwasher were 26 mG and 0.7 mG at 1 and 5 ft respectively. The measurements were taken at 60 Hz. One electric shaver, however, generated its primary field at 120 Hz, and a television without a power transformer produced a 58 Hz field, the vertical sweep frequency. Background levels in the homes where the measurements were taken ranged from 0.5 to 1 mG. (The Earth's natural magnetic field, which is essentially static, is approximately 0.5 G, or 500 mG.) *Household Appliance Magnetic Field Survey,* Technical Report E06549-3, March 1984, was prepared for the US Naval Electronic Systems Command, Washington, DC 20360.

Resources...NBS has published *Electrical Parameters in 60 Hz Biological Exposure Systems and Their Measurement: A Primer,* Technical Note 1191, by M. Misakian. It is available from the Government Printing Office, Washington, DC 20402 for $2.25 (prepaid). Order No. 003-003-02581-1....Georgia Tech's Dr. Glenn Smith has published an article on "Limitations on the Size of Miniature Electric Field Probes," in the June *IEEE Transactions on Microwave Theory and Techniques*.... And a Canadian group headed by Health and Welfare's Maria Stuchly has written a paper on the performance characteristics of implantable E-field probes, which appears in the July *IEEE Transactions on Biomedical Engineering*.

MEETINGS

Hazard Assessment Symposium...EPA is sponsoring a *Symposium on Electromagnetic Field Measurements for Hazard Assessment* on October 10-12 at the Hacienda Resort Hotel and Casino in Las Vegas, NV. In addition, there will be a one-day tutorial, *An Introduction to Non-Ionizing Radiation,* on October 9. Among the topics on the agenda are the limitations of available instrumentation, new broadband and narrowband meters and calibration techniques. For more information, contact: Sheri Marshall, Dynamac Corp., PO Box 2198, Kensington, MD 20895, (301) 468-2500.

DOE-EPRI-NYS Bioeffects Review... This year researchers working under grants from the New York State Power Line Project will join those with funding from DOE and EPRI, who are studying the biological effects of high voltage 60 Hz and DC transmission lines at the 1984 Contractors Review. The meeting will be held at the Sheraton Hotel in St. Louis, MO, November 5-7. A block of rooms has been set aside for participants, and a special rate is available if you mention "DOE" to the reservations operator. Summaries of all the projects will be available two weeks before the meeting. If you are planning to attend or want a copy of the summaries, contact Dr. William Wisecup before September 1, Aerospace Corp., Suite 4000, 955 L'Enfant Plaza, SW, Washington, DC 20024, (202) 488-6328.

MILITARY SYSTEMS

EMP System on Chesapeake Bay... The Navy's plan to build a powerful Electromagnetic Pulse Radiation Environmental Simulator for Ships (EMPRESS II) on Maryland's Chesapeake Bay has met strong opposition from Governor Harry Hughes. In a July 13 response to an angry June 18 letter from Hughes, Secretary of the Navy John Lehman, Jr., promised to complete an environmental impact statement (EIS) before making a final decision on where to site the EMP generator. The Navy hopes to release a draft EIS in August. In order to test how well ship electronics would survive during a war, the EMPRESS II barge-mounted antenna would emit radiation similar to that released by a nuclear explosion. The EMP fields could reach 50 kV/m on ships approximately 100 meters from the proposed antenna. The inverted cone antenna will be 130 ft high by about 200 ft across the top. EG&G Washington Analytical Services Center recently won a $20.3 million contract to design and develop EMPRESS II, which is scheduled to begin operation in 1987. Meanwhile, the Navy is discontinuing use of EMPRESS I, a less powerful, land-based system located at Point Patience, Solomons, MD.

UPDATES

POWER LINES

State Actions...Florida...A $200,000 study of power line health and safety is getting underway in Florida to help the state's Department of Environmental Regulation evaluate the need for new rules. A five-member panel chaired by Professor H.B. Graves of Pennsylvania State University is scheduled to submit a report by January 1. The study is being funded by a consortium of Florida utilities: the state legislature mandated the investigation last year without providing necessary funding (see *MWN*, July/August 1983).

...Nevada...A June 1 federal court decision clearing the way for a ±500 kV power line through Henderson, NV, has been appealed. It all started when the town brought suit last year to move the line. Henderson argued that the environmental impact statement (EIS) for the 500-mile Intermountain Power Project line inadequately addressed health and safety issues and that the U.S. Department of Interior had overstepped its authority in granting route approval. Judge Leland Nielsen of the US District Court of Nevada found that the EIS was adequate, and more importantly, that local law could not take precedent over federal authority to grant right-of-way on federal land (Citizens for a Better Henderson v. James Watt, CV-LV 83-306, HEC). The appeal was filed June 22 in the US Ninth Circuit Court of Appeals in Las Vegas by the plaintiffs' attorney, Elizabeth Foley.

...Virginia...A joint subcommittee of the Virginia legislature set up to study power line health and safety issues (see *MWN*, June 1984) will hold its first hearing on August 9 in the town of Floyd. A second hearing for expert testimony will be held in Richmond in September or October. For information, contact Ms. Terry Mapp, Division of Legislative Services, Virginia Legislature, PO Box 3A-G, Richmond, VA 23208, (804) 786-3591.

VDTs

Regulations for VDT Radiation?... Federal regulation of VDT radiation emissions falls within the authority of the Radiation Control for Health and Safety Act of 1968, according to a legal note published in the November 1983 *Southern California Law Review* (Vol.57, No.1). Author Sheryl Gordon McCloud argues that the Act "enables [the Center for Devices and Radiological Health] to regulate a *risk* of injury," (emphasis McCloud's) and that such a risk exists with VDT radiation emissions. The note, *Pink Collar Blues: Potential Hazards of Video Display Terminal Radiation*, challenges federal policies which assume that available data on VDTs are conclusive. McCloud argues that, "In the face of [the uncertainty about possible hazards], government publications assure us that VDTs are safe and that current standards are adequate. This note seeks to discredit these conclusions and to undermine the complacency they engender." She advocates "that federal rulemakers and policy makers acknowledge that our knowledge of VDT hazards is incomplete, and that our current rules, policies and standards offer no guarantee of safety to workers." Single copies of the law review are available for $9.00 each from the Gould School of Law, The Law Center, University of Southern California, University Park, Los Angeles, CA 90089.

(continued on p.12)

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EPA Options Paper on RF/MW Guidance

As we reported in our June issue, the Environmental Protection Agency's (EPA) proposed guidance for public exposure to radiofrequency and microwave (RF/MW) radiation has met stiff opposition within the agency and may be scrapped. It is now known that the objections are coming from EPA's Office of Policy Planning and Evaluation (OPPE). On May 11, shortly after the draft guidance was submitted for internal agency review prior to publication in the Federal Register, *Deputy Assistant Administrator Jack Campbell of OPPE circulated an options paper recommending that EPA take no regulatory action on RF/MW radiation. The Office of Radiation Programs (ORP), apparently surprised by OPPE's stance, is now lobbying to save the guidance it spent five years developing. Agency officials have remained unusually tight-lipped about the ongoing struggle, and will only say that a decision is expected by fall.*

The full text of Campbell's options paper is printed below. The paper was addressed to Assistant Administrators Joseph Cannon, Office of Air and Radiation, and Bernard Goldstein, Office of Research and Development (ORD).

Options for Addressing Potentially Adverse Health Effects from Public Exposure to Radiofrequency Radiation

ORP'S PROPOSAL

ORP is recommending that EPA use its Federal Radiation Council Authority to propose guidance which would limit public exposure to radiofrequency (RF) radiation. More specifically, ORP's proposal would provide federal guidance that RF exposure to the public should be limited to a whole-body *Specific Absorption Rate* (SAR) equal to or less than 0.04 Watts per kilogram (W/Kg).

ISSUES FOR RESOLUTION

The primary issues requiring resolution are as follows:

1. Should EPA propose guidance?
2. If guidance is to be proposed, what SAR value is appropriate?

BACKGROUND

There are no federal standards/guidelines for controlling exposure of the *general public* to RF radiation in the environment at this time. (But there are FDA standards for microwave ovens, OSHA recommendations for limits on occupational exposures and a voluntary "standard" for occupational exposure developed by the American National Standards Institute (ANSI).)

There is no statutory requirement to promulgate RF limits, but the agency has been requested to prepare guidance by various federal (FCC, NTIA), state and local agencies and private sector groups. Public comments to a December 1982 ANPRM [advanced notice of proposed rule making] strongly supported the development of RF guidance.

ORP believes guidance is needed to: (1) Limit the potential public health consequences of increasing and continuous exposure to RF radiation in the general environment, and (2) Provide a sound basis for (hopefully) uniform state and local standards. Final *promulgation of Federal Radiation Guidance requires the President's signature*. Guidance would not be "enforced" by EPA; each federal agency would be separately responsible for implementing and complying with the guidance, e.g., the FCC is granting or renewing radio licenses.

Important RF sources include such facilities as AM and FM radio stations, television, radar, satellite communication and microwave relay systems, land mobile radio and amateur radio.

Biological Effects

Biological effects are related to the rate at which RF energy is absorbed by an individual. This "dose rate" is usually expressed as watts per kilogram of body mass (W/Kg) and is termed the *Specific Absorption Rate* (SAR). The available information on biological effects of RF radiation have been critically reviewed and summarized in [an] extensive report prepared by ORD; the report has been reviewed and approved by the [Science Advisory Board] (SAB) for the purpose of standard-setting, although the SAB offered no guidance in where the standard should be set.

A very wide range of biological effects has been observed in experimental animals:

- At levels *far* in excess of that found in the general environment, short-term whole-body exposure to RF radiation can be lethal (typically for SAR > 30 W/Kg). Brief exposure to similarly high RF levels in experimental animals has been shown to lead to birth defects, increased resorptions, lower birth weight and reduced survival rates in general.
- At somewhat lower SAR levels of 4-30 W/Kg (but still far above levels found in the general environment), generally observed effects in experimental animals include decreased birth weight, reduced fertility, and various immunologic, hematologic and hormonal effects. Changes in animal behavior have also been observed. (In some experiments, a SAR in the range 4-6 W/Kg has been found to be lethal to rats, dogs and rabbits.)
- At SAR levels *beginning to approach* those that may be formed in this general environment (somewhat less than 4 W/Kg), the public health significance of the observed biological effects are still controversial. Preliminary findings include various neurological, metabolic and histologic changes in animal tissue and cells *in vitro*; behavioral changes in animals exposed under conditions of high ambient temperature and humidity; and some *tentative indication* that RF radiation may act in some cases as a cancer promoter or co-carcinogen in animals at a whole-body SAR of 2-3 W/Kg.

In regard to the Specific Absorption Rate, the ORD report's Summary and Conclusions Section finds that "the data currently available on the relation of SAR to biological effect show evidence for biological effects at an SAR level of about 1 W/Kg. This value is lower by a factor of 4 than 4 W/Kg, the value above which reliable evidence of hazardous effects was found by ANSI (1982) following a review of the literature in February 1979." With respect to body ("core") temperatures, the review's Summary finds that "exposure of human beings at frequencies in the resonant region at an SAR of approximately 1 W/Kg produces significant changes in body temperature under some environmental conditions."

The report thus concludes that the "review of the currently available literature on RF radiation provides evidence that biological effects occur at an SAR of about 1 W/Kg; some of them may be significant under certain environmental conditions."

Public Exposure Data

Over the last decade, ORP has made fairly extensive measurements of RF radiation in the general environment. These measurements were generally made in terms of power densities (rather than SARs) expressed in terms of microwatts per square centimeter (uW/cm^2). Even in urban areas, where RF radiation levels are generally much higher than in rural regions, *very few (if any) individuals in the general public are currently exposed to a SAR of 1 W/Kg.*

ORP studies found that in 15 major U.S. cities 99.4 percent of the population were exposed to power densities < 1 uW/cm^2 in the primary frequency range of interest (equivalent to a SAR of < 0.0004 W/Kg at resonance). About 0.3 percent of the population was found to be exposed to power densities from 1-to-2 uW/cm^2; 0.07 percent from 5-to-10 uW/cm^2 and 0.02 percent from 10-20 uW/cm^2. (For reference, a 20 uW/cm^2 exposure is equivalent to a SAR of about 0.008 W/Kg at resonance.) The median exposure was estimated to be 0.0048 uW/cm^2. Power densities in non-urban areas would typically be several factors of 10 lower. Thus, only a very small fraction of the population is exposed to RF levels that even approach those that are currently thought to be significant. The maximum level measured in urban ground-level locations commonly frequented by people was 10.9 uW/cm^2 (equivalent to SAR of about 0.004 W/Kg (at resonance)).

Sources likely to produce the most significant population exposure levels are FM radio and VHF television stations. *Field intensities generally decrease rapidly as one moves away from the broadcast tower.* Power densities from FM radio stations, for example, typically drop by a factor of 10 as one moves away from the base of the tower by a distance on the order of 150 feet. EPA measurements inside high buildings that are close to broadcast antennas have found power densities up to about 100 uW/cm^2 (or about 0.04 W/Kg at resonance). In special circumstances, EPA measurements at locations containing multiple-towers and/or multiple-antennas in very close proximity found power densities on public property of up to about 7,000 uW/cm^2 (or about 2.8 W/Kg at resonance). While often accessible to the general public, comparatively few people approach such locations and those people are typically there for only a brief period.

ORP's Rationale for the Proposed 0.04 W/Kg Standard

ORP is proposing to take this 1 W/Kg SAR value and reduce it to 0.04 W/Kg to derive RF guidance for the general public. (In the draft proposal, ORP actually starts with a SAR value of 4 W/Kg, a level at which biological effects are "obviously adverse," and reduces it to 0.04 W/Kg by using a safety factor of 100.)

The basis for ORP's proposal is as follows:

- The 4 W/Kg SAR "observed effects" level is based largely on animal data for short-duration exposures under non-stressful temperature and humidity conditions. (At higher temperature and humidity conditions, effects should occur at lower SARs.)
- There is currently little information on long-term effects in animals or humans.
- There are considerable differences in human susceptibility to thermal stress. Young children and older individuals are especially sensitive.
- Some biological effects are known to occur below 4 W/Kg.
- The SAR within specific parts of the body can exceed the whole-body average SAR value by as much as a factor of 100.
- For *occupational* exposures, the "safety factor" selected by the American National Standards Institute for its voluntary standard was 10. (For ionizing radiation, an additional factor of 10 is used to go from an occupational to a general population standard. A similar choice for RF radiation would result in an overall safety factor of 100.)
- Ambient temperature and humidity conditions in the general environment may be such as to impose thermal stress even ignoring the additional thermal stress potentially associated with RF radiation.
- Mathematical simulations suggest a 2.3 W/Kg SAR should lead to a 1 degree C increase in human ("core") temperature. (Occupational standards recommend that workers should not be permitted to continue their work when their temperature rises by 1 degree C.) A 1 W/Kg SAR is estimated to increase core temperature by about 0.5 degree C.
- Economic impacts do not appear to be especially sensitive to the safety factor of 100. (More on this shortly.)

OPPE Position

OPPE recommends Option 1 [see below] which provides for the dissemination of all available health information to the public, FCC and others interested in this issue. OPPE does not believe available data indicate a need for EPA regulation, because:

- There are only a few facilities (if any) exposing individuals to RF radiation at levels where adverse effects have been observed in animal studies.
- Studies did not show effects thought to be adverse until the SAR was > 1 W/Kg, while it is true that most animal studies were short in duration and didn't account for higher temperature or humidity. This is several orders of magnitude above typical exposure levels.
- We have no basis to assume that long-term biological changes will be adverse to human health. This kind of uncertainty is common among EPA's health related actions.
- It is probably true (although we don't have epidemiological data that children and the elderly are more sensitive to RF radiation but the number of exposed people must be remembered: 99.4 percent of the urban population and (presumably) essentially 100 percent of the rural population are exposed to less than 0.0004 W/Kg. (The remainder of the urban population is thought to be generally exposed to less than 0.008 W/Kg.)
- It is true that biological effects are known to take place below 4 W/Kg but *it is not established that these are adverse to human health.*
- The safety factor of 10 chosen by ANSI is arbitrary; the safety factor of 100 proposed by ORP is equally so; *both are well below the observed health effects level.*
- While it is possible that ambient weather conditions could exacerbate RF health effects, this possibility has *not* been studied in detail sufficient enough to be used for guidance (at the RF radiation levels normally found in the general environment).
- It is true that the cost to society of this standard is not enormous. However given the remote probability that someone would die of ambient RF exposures, the *cost per life saved of this standard is infinite.*
- The 0.04 W/Kg standard is inconsistent with the risk management decisions EPA has made in: (a) benzene (NESHAP) (b) arsenic (NESHAP) (c) asbestos (Section 5 TSCA) (d) EDB (e) SO2 (NAAQS) (f) PM (NAAQS).
- It has been suggested that an EPA standard will give the public assurance that they are safe from RF. If this is true, exposures above the standard would probably be perceived as dangerous (even though perhaps below the observed effects level). We have no assurance that states won't automatically regulate below *any* EPA standard.

Compliance Measures

At broadcast stations where guidance is exceeded, ORP suggests there are generally several alternative ways to achieve compliance. Depending on circumstances, these may include:

- Post area over guideline;

- Replace existing antenna with a more efficient design with standard 1-wavelength spacing;
- Replace existing antenna with 1/2-wavelength spacing;
- Lease on taller existing tower;
- Build new tower on an existing site;
- Build a tower on a new site; and
- Prohibit public access.

Economic Impacts

For commercial *broadcast* stations, preliminary estimates indicate that the exposure limit of 0.04 W/Kg ORP is recommending would have an estimated net total present value cost of about $22 to $52 million (1983$). Actual expenditures would be expected to be spread over a six year period. Mid-range cost estimates and the estimated number of affected facilities for various SAR levels are as follows:

SAR	Economic Impacts[1]	Number of Stations Potentially Affected[1]
4.0 W/Kg	$11 million	178
1.0 W/Kg	$12 million	456
0.4 W/Kg	$15 million	1122
0.08 W/Kg	$28 million	1745
0.04 W/Kg	$39 million	3361

[1]ORP staff state that these are "worst-case upper-limit" estimates and indicate that further analysis will substantially reduce both the cost estimates and the potential number of stations affected.

These estimates are currently being revised, but ORP staff believe the costs are not expected to change markedly. ORP is currently surveying FM radio stations to determine actual land use in the immediate vicinity of the transmitting towers. Results are not expected for some months, but ORP staff expect this information may lead them to reduce cost estimates significantly.

Non-broadcast sources (e.g., radars and satellite communication systems) were also studied. Theoretically calculated field intensities were estimated. The number of government installations affected by the guidance was found to be a few percent of the total number of installations. No cost analyses were performed for these sources, however, because of the lack of cost data for much of the military equipment and the great diversity of site parameters.

OPTIONS

Given the above information, several options seem worthy of consideration from OPPE's standpoint. ORP recommends Option 5.

1. Distribute Information to the Public.

Take no regulatory action but distribute health data to the public, noting that people are safe given expected exposure rates. Continue research if necessary.

a. Pro: (1) Avoids unwarranted fears that could result from setting a stringent standard. (2) Gives states, cities and the FCC assurance that people are not at risk. (3) Avoids inconsistency with ANSI (occupational) standard. (4) Avoids the need to make a sweeping risk management decision which might result in economic impacts that go beyond what can be currently estimated. (5) Avoids unnecessary expenditures of society's resources. (6) Exposures to RF radiation which may result in adverse health effects could still be addressed by FCC and others using EPA health data.

b. Con: (1) Could be perceived as unresponsive to state, FCC and industry requests for a standard. (2) Would offer no protection.

2. Take No Action at This Time.

Since EPA is not required by statute to propose RF guidance, taking no action at this time would permit ongoing biological, technical and economic analysis to be further refined.

a. Pro: (1) Since the general population is presently under little, if any, risk from RF radiation, an extended delay to permit further advances in the bioeffects research makes it possible to substantially improve the guidance when issued within the next few years. (2) In principle, RF guidance developed after a delay significant enough to permit a substantial increase in our knowledge base should be better able to protect the public with less chance for economically burdensome impacts due to an overly protective standard. (3) Consistent with current understanding of effects at known exposure levels over short periods of time.

b. Con: (1) Not responsive to federal, state and local requests for RF guidance. (2) More (non-uniform) state and local standards could be established and these could impose a greater cost to society than Options 3-5. (3) Some additional installations of new RF sources could be stopped or delayed by undue public concern over RF radiation.

3. Base Proposed Guidance on a SAR of 1.0 W/Kg.

ORP's draft would be revised to conform to a maximum SAR of 1.0 W/Kg.

a. Pro: (1) A SAR of 1.0 W/Kg is the level at which the bioeffects document identifies as producing potentially significant biological effects. (2) Low estimated cost to society ($12 million, spread over six years). (3) Substantially lower than existing (but dated) OSHA guidance for occupational exposure based on a maximum SAR of 4.0 W/Kg. (4) Some states and cities are likely to establish standards more stringent than EPA guidance. As a result, guidance of even 1.0 W/Kg may be translated into much lower levels. (5) Small exposed populations (essentially zero).

b. Con: (1) Higher than recent occupational guidance recommended by ANSI (0.4 W/Kg). (2) Inconsistent with the current *draft* recommendations being prepared by the National Council for Radiation Protection and Measurement (NCRP) which recommends a maximum SAR equivalent to 0.08 W/Kg. [NCRP is a non-profit corporation chartered by Congress that collects, analyzes, develops and disseminates information and recommendations about radiation protection and radiation measurements, quantities and units.] (3) A 1.0 W/Kg SAR limit could lead to an estimated human "core" temperature increase of about 0.5 degree C; this increase could be significant under certain ambient heat and humidity conditions, especially for certain sensitive populations exposed to continuous doses for extended periods of time.

4. Base Proposal on a SAR of 0.4 W/Kg.

ORP's proposed guidance would be revised to conform to a SAR of 0.4 W/Kg.

a. Pro: (1) Relatively small cost to society ($15 million, spread over six years). (2) In theory, fewer people would be exposed to higher SAR values since exposures between 0.4 and 1 W/Kg would be inconsistent with the guidance. (But since the number of people receiving an average SAR in this range is extremely small, the actual significance is uncertain.) (3) Below the level at which there are known adverse health effects in animals. (4) Consistent with ANSI's occupational guidance.

b. Con: (1) Could indicate to the public that levels above 0.4 W/Kg are dangerous whereas data indicate otherwise. (2) Inconsistent with other EPA actions in that it is below the no observable health effects level. (3) Could be perceived as inadequate because it permits public exposures at a level equal to the generally accepted occupational guidance by ANSI. (4) Could lead to heat stress for some temperatures and humidity conditions for *some* population groups (the young, the aged and those with cardiovascular disease), if these individuals remain within 100-200 feet of the facility for a continuous period of time. (5) No certainty that states and cities will adopt it; they could adopt a more stringent standard.

5. Base Proposed Guidance on a SAR of 0.04 W/Kg.

(ORP's proposal)

a. Pro: (1) Strongly protective of public health in relation to Options 1-4 above. (2) Consistent with the usual practice of generally providing substantially more protective standards for the general public than those established for occupational exposures. (3) A 0.04 W/Kg SAR limit should protect against any thermally-related health effects in all human populations even under *adverse* temperature and humidity conditions, based on available data. It would result in a maximum estimated 2-to-4 percent increase over the basal metabolic rate.

b. Con: (1) Relatively high cost to society ($39 million, spread over six years). (2) No known health benefit for costs incurred in setting a standard below 1 W/Kg. (3) Seems inconsistent with recent agency decisions in that it is well below the known observable health effects level. (4) No certainty that states and cities will adopt it; they could adopt more stringent standards.

UPDATES *(continued from p.8)*

Legislation... The California Assembly defeated bill number 3175 by 37-25, after the Ways and Means Committee approved the measure by a narrow margin. The committee-passed version was markedly different from the bill originally introduced by Assemblyman Tom Hayden (see *MWN*, May 1984). The amended bill, though weakened in many respects, still would have required employers either to shield terminals to block non-ionizing radiation emissions or to provide alternative work during pregnancy for operators; the bill also would have established a task force to determine how to protect VDT workers. Following the Assembly's vote, Hayden asked that the bill be sent back to the Labor Committee for further hearings. This motion was approved and new hearings are expected in the fall....In Connecticut, state officials, computer manufacturers and labor groups have agreed to form a VDT study task force, following the completion of a study required by a 1983 law (see *MWN*, June 1983). No meetings have been held yet, and no agenda has been prepared....Massachusetts legislators have added $75,000 to the state's fiscal 1985 budget for a VDT health and safety study. Originally advocated by Representative Elizabeth Metayer as an amendment in the House of Representatives, the money will be used by the Department of Labor and Industries' division of occupational hygiene to "evaluate virtually every aspect of VDT work," according to a legislative staffer. The budget officially took effect on July 1, but no timetable has been set for the study....Representative Karen Clark introduced Minnesota's first VDT legislation earlier this year, but no action was taken on the measure. Bill number H.F. 2333 would have required employers to provide adjustable furniture and terminals, glare reduction procedures and annual eye examinations. Semiannual testing for radiation emissions "above allowable standards" and alternative work during pregnancy also were included in the legislation.

CONFERENCES

September 10-13: **4th International Conference on Dielectric Materials, Measurements and Applications,** University of Lancaster, England. Contact: Institution of Electrical Engineers, Savoy Place, London WC2R OBL, England, (01) 240-1871, ext. 222.

September 10-13: **14th European Microwave Conference,** Liege, Belgium. Contact: Microwave Exhibitions & Publishers, Convex House, 43 Dudley Rd., Tunbridge Wells, Kent TN1 1LE, England.

September 17-19: **19th Annual Microwave Power Symposium,** Minneapolis Plaza Hotel, Minneapolis, MN. Contact: IMPI, Suite 520, 301 Maple Ave. West, Vienna, VA 22180, (703) 281-1515.

September 17-19: **37th Annual Conference on Engineering in Medicine and Biology,** Los Angeles Hilton, Los Angeles, CA. Contact: Patricia Horner, Alliance for Engineering in Medicine and Biology, Suite 402, 4405 East-West Hwy., Bethesda, MD 20814, (301) 657-4142. The **6th Annual Conference of the IEEE-Engineering in Medicine and Biology Society** will meet September 15-17 immediately before the ACEMB meeting.

September 17-21: **NATO Advanced Research Workshop on Interactions Between Electromagnetic Fields and Cells,** Erice, Italy. Contact: Professor A. Chiabrera, Biophysical and Electronic Engineering Dept., Via all'Opera Pia 11A, 16145 Genoa, Italy, (10) 311811.

September 18-21: **4th International Conference on Electromagnetic Compatibility,** University of Surrey, Guildford, England. Contact: Institution of Electronic and Radio Engineers, 99 Gower St., London WC1E 6AZ, England, (01) 388-3071.

September 26-28: **International Symposium on Electrostatics —Applications & Hazards,** Polygon Hotel, Southampton, England. Contact: Helen Raquet, Oyez Scientific and Technical Services, Bath House, 56 Holborn Viaduct, London EC1A 2EX, England, (01) 236-4080.

October 2-4: **Interaction of Biological Systems with Static and ELF Electric and Magnetic Fields,** Holiday Inn, Richland, WA. Contact: Patricia Bresina, Battelle Pacific NW Labs, PO Box 999, Richland, WA 99352, (509) 376-0100.

October 2-4: **6th Annual Electrical Overstress/Electrostatic Discharge Symposium,** Marriott Hotel, Philadelphia, PA. Contact: EOS/ESD Symposium, PO Box 9172, Fort Collins, CO 80525, (303) 221-8059.

October 10-12: **Symposium on Electromagnetic Field Measurements for Hazard Assessment,** Hacienda Resort Hotel and Casino, Las Vegas, NV. Contact: Sheri Marshall, Dynamac Corp. PO Box 2198, Kensington, MD 20895, (301) 468-2500.

October 16-18: **1984 International Symposium on Electromagnetic Compatibility,** Tokyo, Japan. Contact: Professor T. Takagi, Dept. of Communications, Tohoku University, Sendai, 980, Japan, (0222) 22-1800, ext. 4266.

MICRO WAVE NEWS

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RF and VLF Radiation Hazards Reappraised

The health risks associated with exposure to 30-70 MHz radiofrequency (RF) radiation are greater than previously believed, according to Professor Om Gandhi of the University of Utah. This new finding, together with previous research on shocks and burns from very low frequency (VLF) fields (300 kHz-3 MHz), could force a reappraisal of the adequacy of current safety standards, possibly leading to changes in the operation of broadcast transmitters and of industrial machinery such as RF sealers and heaters.

Gandhi has found that a 1 mW/cm² 40 MHz field induces a maximum current of 780 milliamps (mA) through the ankles in a free standing adult. Gandhi estimates that the resulting local specific absorption rate (SAR) in the ankles is 243 watts per kilogram (W/Kg). Such "hot spots" may present a risk of burns and other internal injuries.

Present exposure standards seek to limit *whole-body* SARs — for instance, the 1982 American National Standards Institute (ANSI) guidelines are keyed to a maximum SAR of 0.4 W/Kg. The ANSI standard also has a clause that specifies a maximum partial-body exposure of 8 W/Kg. The National Institute for Occupational Safety and Health (NIOSH) has recently proposed a similar partial-body limit of 5 W/Kg (see story on p.2). Gandhi has thus measured levels that are nearly 50 times greater than NIOSH's proposed local SAR limit.

Gandhi has also calculated the SARs for children in a radiation field. For a 10-year-old child standing in a 1 mW/cm² field, the maximum local SAR is 371 W/Kg at 50.7 MHz. A 5-year-old child experiences a maximum local SAR of 534 W/Kg at 62.5 MHz.

In a telephone interview, Gandhi said that the fields cause "very large currents" to pass through the human body: "What we thought were very low fields can nevertheless induce currents with very large local SARs." Gandhi, who is with the Department of Electrical Engineering at the University of Utah in Salt Lake City, told *Microwave News* that, "We must understand the role such high currents play in the human body."

According to Gandhi, up to 85 percent of the current passing through the ankles is also flowing through the abdominal region. To put the numbers into perspective, he explained that, *without* cooling by blood flow, an SAR of 70 W/Kg can cause a 1 degree Centigrade rise in body temperature per minute.

Of course, increased blood flow does cool off heated tissue, but whether it can do so before any damage occurs and whether the body's thermoregulatory system can handle the increased heat load are still unresolved questions and in need of study.

Some of Gandhi's data appear in the June issue of the *Proceedings of the IEEE, 73,* 1145-1147. The paper was submitted more than a year ago, and some of the results have now been revised with higher SARs than were originally reported.

(continued on p.9)

HIGHLIGHTS

NIOSH Proposes RF/MW Occupational Standard – Stricter Than ANSI's

The National Institute for Occupational Safety and Health (NIOSH) has proposed worker exposure standards that are, for many frequencies, twice as strict as those set by the American National Standards Institute (ANSI) in 1982. The NIOSH proposal is part of a 293-page draft criteria document on occupational exposures to radiofrequency and microwave (RF/MW) radiation, released at the Bioelectromagnetics Society (BEMS) meeting held in San Francisco, CA, in mid-June.

In the external review draft of the criteria document, NIOSH proposes to limit worker exposures to a maximum of 0.5 mW/cm^2 for the 30-300 MHz frequency range. For 300 kHz-3 MHz, the maximum exposure would be 50 mW/cm^2. Like the ANSI standard, NIOSH proposes adopting a "ramp" type, frequency-dependent standard. Above 3 GHz, the NIOSH proposal would be 5 mW/cm^2, identical to ANSI's. (Excerpts from the NIOSH recommended exposure standard appear on pp.8-9.)

NIOSH is now in the process of soliciting comments on the draft criteria document from experts inside and outside the federal government. A revised draft will then be reviewed by Dr. Donald Millar, director of NIOSH. If approved, the final document should be issued next year.

The completed NIOSH document will be forwarded to the Occupational Safety and Health Administration (OSHA), which could set a standard for workplace exposures — though at present OSHA has no plans to do so (see *MWN*, November 1983 and March 1984).

Such a standard could affect a large number of workers. According to a report prepared for OSHA in 1982 by Centaur Associates, nearly nine million Americans are exposed to non-ionizing radiation on the job.

Basis for the Standard

The NIOSH standard is based on a threshold for adverse bioeffects at a specific absorption rate (SAR) of approximately 2 W/Kg. Using a safety factor of 10, NIOSH recommends that average whole-body SARs be limited to 0.2 W/Kg. In comparison, the ANSI standard is keyed to an average SAR of 0.4 W/Kg.

According to NIOSH, "No measurable core temperature increases are expected to occur in man or animals at SARs of 0.2 W/Kg or less. Few substantiated biological changes of any type have been reported in animals at SARs lower than 0.2 W/Kg, and the changes that occurred were not judged by NIOSH to have any significant effect on the health of the animal. SARs below 0.2 W/Kg are thus not expected to have any significant effect on man....The 0.2 W/Kg limit should prevent any additional increase in body temperature due to RF exposure, regardless of the ambient conditions."

In a paper presented at the BEMS meeting, "Assessment of the Biological Effects of RF Radiation," NIOSH's Dr. Joseph Lary, Dr. David Conover and William Murray summarized the basis for the NIOSH recommendations:

> Several adverse effects have been reported at SARs between 1.8 and 4.5 W/Kg including death (rats and rabbits); rectal temperature increases exceeding 3 degrees C (monkeys, dogs); hemorrhagic lesions, other tissue lesions, and tubular nephrosis (rabbits); staggering, muscular flaccidity and collapse, and spasms of the legs and wings (chicks); and extreme agitation, impaired locomotion, and exhaustion (dogs). At SARs exceeding 4.5 W/Kg, prolonged exposure generally produced severe hyperthermia in most animals and caused a variety of adverse health effects. At SARs below 1.8 W/Kg, no biological effects were reported which were considered by the authors to be clearly adverse to the animals' health. However, in the SAR range of 0.17-1.8 W/Kg, measurable increases in body temperature were reported as well as several distinctive physiological and behavioral changes. At SARs below 0.17 W/Kg, no temperature increases were reported and most of the biological effects involved increases in calcium efflux from the brain or increased permeability of the blood-brain barrier.

With respect to the calcium efflux effect, the NIOSH staffers argued that it "has no known significance to the health of the animal." As to the possibility of microwave-induced leakage through the blood-brain barrier, they concluded that this effect "has been difficult to replicate at low exposure levels and may be an experimental artifact."

The 0.2 W/Kg exposure limit should protect against any "significant interactions between RF radiation and drugs or chemical substances to which the worker might be exposed," according to the draft document. Of special concern, NIOSH cited the finding that RF/MW radiation can enhance the carcinogenicity of benzopyrene in mice at SARs as low as 2.0 W/Kg.

In the criteria document, NIOSH explains the need for the safety factor of ten partly because of uncertainty over heating effects in humans and rhesus monkeys — the agency notes that no significant temperature rise occurs in animals at SARs below 0.17 W/Kg — and partly because theoretical models indicate that the human thermoregulatory system is not affected at levels below 0.2 W/Kg. In addition, NIOSH cites the fact that "little is known about the long-term effects of chronic exposure of workers to RF radiation" and that, "The epidemiology literature presently does not provide an adequate basis to determine the long-term human health effects, if any, from exposure to RF radiation."

Under the NIOSH proposal, average whole-body exposures can exceed 0.2 W/Kg if partial-body exposures are not over 5 W/Kg — averaged over any one gram of tissue. The 1982 ANSI standard has a similar exclusion clause but with a maximum peak SAR of 8 W/Kg.

NIOSH explains: "It thus appears that continuous lo-

calized exposure of even poorly perfused tissues at an SAR of 5 W/Kg will not result in a localized temperature increase of more than a few tenths of a degree Centigrade and will not damage the exposed tissue." This 5 W/Kg limit should protect the lens and the pituitary gland from localized RF power deposition, according to NIOSH.

RF Shocks and Burns

NIOSH is seeking to protect workers against shocks and burns, irrespective of the ambient field:

> Exposure conditions which will cause an involuntary response (startle reaction) due to an RF shock or current flow are not permitted from 300 kHz to 300 GHz. In addition, exposure conditions which will cause an RF burn are not permitted from 300 kHz to 300 GHz. These restrictions apply even if the exposure limits of this standard are not exceeded.

For frequencies below 3 MHz, NIOSH concludes that the 50 mW/cm^2 exposure limit will protect workers against shocks, burns or excessive SARs *if* there is no contact with a conducting object. When such a contact is made, however, the risks are much greater.

For instance, the NIOSH staffers cite estimates that a worker in a 3 MHz electric field at 50 mW/cm^2 who touches a grounded conductive object with his hand could experience an SAR of 16,625 W/Kg, a level which "would obviously cause an RF burn or a possible accident-causing startle reaction."

NIOSH does not propose controlling RF shock and burn risks by limiting ambient field strengths, however. Instead, the agency advocates that such hazards "are best prevented by implementing appropriate safety features on a source-by-source basis rather than by limiting the incident field." The use of insulated gloves, shoes and other protective clothing is suggested as a possible control strategy.

NIOSH's Consultants

In preparing the document, NIOSH staffers consulted the following experts: Dr. Ernest Albert, George Washington University Medical Center, on central nervous system effects; Drs. Virginia Bruce-Wolff and Don Justesen, VA Hospital, Kansas City, on behavioral effects; Dr. Russell Carpenter, Food and Drug Administration, on ocular effects; Dr. Om Gandhi, University of Utah, on dosimetry; Dr. Ronald Jensh, Thomas Jefferson Medical College, on reproductive effects; Dr. Robert Lebovitz, University of Texas Health Science Center, on auditory effects; Dr. Robert Liburdy, U.S. Air Force School of Aerospace Medicine, on hematologic/immunologic effects; Dr. Shin-Tsu Lu, University of Rochester, on cardiovascular effects; Dr. Sol Michaelson, University of Rochester, on pathophysiological effects; and Dr. Vernon Riley, Pacific Northwest Research Foundation, on neuroendocrine effects.

Editor's Note

Microwave News Goes Bimonthly

With this issue, *Microwave News* begins a new publication schedule in a new, expanded format. Each issue will now be 16 pages long, and we will now publish bimonthly, rather than 10 times a year. These two changes, taken together, will result in essentially the same amount of news coverage over the year, while allowing us to cut costs.

We are making these changes to forestall an increase in subscription price. We have not raised our prices for three years and are reluctant to do so now, even though our expenses have gone up substantially.

Microwave News enjoys a very high renewal rate and we thank you for your loyalty. We trust that the changes we are making now will not affect your reliance on the newsletter as the premier source of information in the field. We encourage subscribers who are adversely affected by this change to contact us.

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If you count on us for all the news from the nonionizing radiation community, we urge you to tell your associates how valuable the newsletter is. If we expand our subscription base, we will be able to hold off future price increases.

If you are reading someone else's copy, please get your own. If the newsletter takes a long time to circulate around your office, consider taking out additional subscriptions. If you are reading a photocopy, you are *breaking the law* and you should definitely subscribe.

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The September/October issue of *Microwave News* will be published about three weeks late. We will resume our regular publishing schedule with the November/December issue.

ELF and Cancer: An Update

The number of papers and letters on the suspected link between extremely low frequency (ELF) radiation and cancer continues to grow. Reported below are the latest developments. (See also *MWN*, October 1984 and May 1985.)

Neuroblastoma Risks

Drs. Margaret Spitz and Christine Johnson have found that the children of fathers exposed to electromagnetic fields on the job had a significantly increased risk of developing neuroblastoma, a malignant tumor of the central nervous system (a twofold elevated risk: odds ratio of 2.13). Males who reported themselves to be electronics workers had an even greater risk of fathering children with neuroblastoma — though the number of such cases was small, the odds ratio was 11.75.

The researchers conclude that, while there are "inherent problems" associated with the use of indirect measures of exposure and of occupational groupings, as well as the possible confounding problem of chemicals and heavy metals, "Even a suggestive association [between electromagnetic fields and] childhood cancer is disconcerting, and replication studies in other populations are warranted."

Spitz is at the M.D. Anderson Hospital and Tumor Institute at the University of Texas, and Johnson is at the University of Texas School of Public Health, both in Houston. Their paper, "Neuroblastoma and Paternal Occupation: A Case-Control Analysis," appears in the June 1985 issue of the *American Journal of Epidemiology, 121,* 924-929.

Leukemia in Canada

High voltage power line workers have a threefold increased risk of dying of leukemia, according to Dr. Geoffrey Howe of the National Cancer Institute of Canada in Toronto. This finding emerged from a broader study of cancer mortality in Canada by Howe and Dr. Joan Lindsay, an epidemiologist with Statistics Canada, also in Toronto (see their paper in the *Journal of the National Cancer Institute, 70,* 37-44).

In a telephone interview, Howe told *Microwave News* that while the increased risk to power line workers is statistically significant, the number of cases studied is small. He explained that his research is designed to generate hypotheses rather than to yield conclusions about specific types of occupational risks. He said that, given the observed increased risk to power linemen, "the time has come to do some definitive studies." Howe plans to submit a letter to *Lancet,* the British medical journal, on the power line-leukemia link.

Brain Tumors

In our October 1984 issue, we reported on results obtained by Dr. Ruey Lin and colleagues at the Maryland Department of Health and Mental Hygiene which suggest a link between exposure to electromagnetic fields and the development of brain tumors. Their paper has now been

Symposium on Electropollution and Brain Tumors

Nobel laureate Dr. Marshall Nirenberg will head the list of participants at a symposium on the *Biological Effects of Electropollution: Brain Tumors and Experimental Models* to be held September 9 at Howard University in Washington, DC.

Dr. Sisir Dutta of the university's Departments of Botany and Oncology and Dr. Richard Millis of the Departments of Neurology and Zoology are organizing the university-sponsored meeting.

Other participants include: Dr. Carl Blackman of the Environmental Protection Agency (EPA), Dr. Om Gandhi of the University of Utah, Dr. Eugene Goodman of the University of Wisconsin-Parkside, Dr. B.E. Hackley of the U.S. Army's Institute of Chemical Defense at Edgewood Arsenal in Maryland, Dr. Bruce Kleinstein of Information Ventures, Dr. Ruey Lin of the Maryland Department of Health and Mental Hygiene and Dr. Margaret Spitz of the M.D. Anderson Hospital and Tumor Institute at the University of Texas in Houston.

Dutta and Millis are inviting researchers in the field of radiofrequency and microwave radiation biology who want to participate in the afternoon session to submit a letter of inquiry or an abstract. According to Millis, there are still five open slots for speakers; those selected will receive funds for travel and accommodations.

Nirenberg, the chief of the Biochemical Genetics Laboratory at the National Heart, Lung and Blood Institute in Bethesda, MD, has developed an experimental model for the study of neuroblastoma and will discuss potential applications at the meeting.

Dr. Joe Elder of the EPA will be the luncheon speaker, addressing the public policy issues associated with electropollution.

The symposium is open to the public, but attendance is limited to about 60. Pre-registration is required, but there is no fee. The proceedings of the meeting will be published. The symposium will be held at the Howard University Inn, adjacent to the campus.

For more information, contact Dutta or Millis at Electropollution Symposium, PO Box 83, Howard University Administration Bldg., Washington, DC 20059, (202) 636-6933.

published: "Occupational Exposure to Electromagnetic Fields and the Occurrence of Brain Tumors" appears in the June issue of the *Journal of Occupational Medicine, 27,* 413-419.

In addition to their earlier findings, Lin and coworkers report that "the mean age at death was found to be significantly younger among cases in the presumed high [electromagnetic] exposure group."

Responses to Milham

Dr. Samuel Milham's April 6 letter to *Lancet* claiming support for the hypothesis that electromagnetic fields are carcinogenic (see *MWN,* May 1985) has generated a number of replies, which in turn have prompted comments.

Two letters, published in the May 11 issue of the journal, contend that the "Silent Keys" column in the American Radio Relay League's (ARRL) *QST* magazine, used by Milham as an index of recent deaths, is incomplete and that Milham had failed to control for the hazards of dust and fumes from soldering electronic components.

Harsher criticism came from ARRL's Committee on the Biological Effects of RF Energy, chaired by Raymond Wrangler, in a letter in the June 29 *Lancet.* The committee members argue that Milham's "hypothesis that electromagnetic fields are carcinogenic remains purely speculative" and that, "On the basis of the data we have seen, it cannot be assumed that participation in amateur radio activities increases the risk of leukemia." They are also critical of Milham's use of proportional mortality ratios (PMRs).

Then, in the July 13 issue, Dr. Michael Coleman of the ICRF Cancer Epidemiology and Clinical Trials Unit in Oxford, England, took the ARRL committee to task for its "inaccurate commentary" on Milham's original letter, including the discussion of PMRs. Coleman also explained that, even if the "Silent Keys" column omitted some cases, the impact on Milham's analysis would be minimal: "Milham's result could be wrong — but it is unlikely to be far wrong. Any bias toward preferential reporting of leukemia deaths...would have to be severe; Milham would need to have missed over 1,500 deaths, not one of them due to leukemia, for his result to be entirely due to such a bias."

In 1983, Coleman reported that he and coworker Janine Bell had found a statistically suggestive link between ELF and leukemia in a population of electrical workers in southeast England (see *MWN,* June 1983).

Epidemiology Handbook

Drs. Tim Aldrich and Clay Easterly of Oak Ridge National Laboratory have assembled a *Handbook of Epidemiologic Methods with Special Emphasis on ELF Fields,* a guide to the literature on ELF effects, focusing primarily on the possible link to cancer. Copies will be available soon at no cost. Write to the authors at the Health and Safety Research Division, Oak Ridge National Lab, Oak Ridge, TN 37831. Include a self-addressed mailing label.

Portland, Oregon Proposes 100 uW/cm² Standard – Again

The City of Portland's Bureau of Planning has reaffirmed its support for a general population exposure standard of 100 uW/cm² for 30-300 MHz radiation. A new proposal by the bureau calls for regulation of the siting and operation of all television and radio stations in Portland, the largest city in Oregon.

The new initiative, issued in July, is intended to clarify the existing regulatory framework, which the city planners found to be inconsistent and, sometimes, inequitable. If approved by the City Planning Commission and the City Council, the plan will require operators of all existing radio and television broadcasting facilities in the frequency band between 100 kHz and 300 GHz to register with the city. Those seeking to build new broadcasting stations will have to apply to the city and conduct radiation measurements around the proposed sites.

The Planning Commission held hearings on the bureau's proposal on July 23 and is expected to reach a decision by September. The City Council will not take final action before December.

Over the 100 kHz to 300 GHz range, the proposed Portland standard is ten times stricter than the 1982 American National Standards Institute (ANSI) standard. The planning bureau concluded that the ANSI limit "does not allow a sufficient margin of safety from known adverse impacts on living tissues."

Portland adopted a 100 uW/cm² interim standard in 1980 — the first public exposure standard in the United States. Although the rules were approved by the Planning Commission, they were never incorporated into the city's zoning rules by the City Council.

In September 1984, the City Council passed an ordinance placing a moratorium on new permits for radio and television facilities until July 1, 1985. In June, the council extended the moratorium until completion of its regulatory review or until January 1, 1986, whichever comes first. According to Steven Gerber, the principal author of the proposed regulations, the moratorium only applies to "major" sources — those with an effective radiated power of 500 or more watts. Thus point-to-point and mobile communications systems are exempt.

The planning bureau contends that its new recommendations "are intended to provide a consistent and knowable set of criteria for the operation and siting of RF broadcast facilities, while providing protection to the general population from RF emissions and the aesthetic impacts of significant broadcast facilities."

The situation in Portland is complicated by the fact that Multnomah County, in which Portland is situated, has its own radiofrequency and microwave radiation standard — 200 uW/cm² in the 30-300 MHz band. Originally, the county had proposed a 50 uW/cm² standard, but backed off in the face of opposition from local broadcasters (see *MWN,* July/August 1982). The city's new proposal is very similar to the county rules, but the exposure levels are

twice as strict. According to the bureau's report, the Portland measure "has been written specifically to be compatible with the Multnomah County regulations."

The Portland planners argue that their proposal will not have any adverse economic impacts. They state that "There is no evidence that the admittedly conservative 100 uW/cm^2 standard will cause any significant hardship on the broadcast industry here in Portland." In addition, they have found no firm evidence "to suggest a negative impact on property values from proximity to broadcast facilities."

The Bureau of Planning has issued a three-volume report, *Radiofrequency (RF) Regulatory Review Project*, consisting of a "Report and Recommendations to the Planning Commission," a "Background Document" and a "Technical Appendix."

In the process of preparing the report, the bureau set up an RF Task Force, consisting of citizens, industry representatives and medical and technical experts.

For more information, contact Steven Gerber, Bureau of Planning, City of Portland, Room 1058, 1120 SW Fifth Ave., Portland, OR 97204, (503) 796-7706.

Hawaii Broadcasts Blamed for Burns and Extensive EMI

Radiation from broadcast antennas in Honolulu, Hawaii, is being blamed for shocks, burns and numerous instances of electromagnetic interference (EMI) with electronic equipment in high-rise condominiums neighboring the radio tower.

A study commissioned by Honolulu Councilmember Marilyn Bornhorst and released in June found that AM radio (550 kHz-1.6 MHz) broadcasts are a potential source of injury and are disrupting telephone answering machines and radio and television reception.

Richard Melton, a consultant who surveyed the residents of three condominiums for Bornhorst, concluded that metal objects in the apartments pose a danger of shocks and burns, ranging from "mild to capable of causing injury." He warned that "The severity of some of these problems is alarming and indicates a continuing danger of injury."

In the report, Melton characterized the interference as a "significant nuisance to many residents" at the two buildings closest to the transmitters — 100-250 feet from Ala Wai tower, from which 3 AM stations broadcast. At the third building, which is about 350 feet from the tower, reports of EMI-type disturbances were less common. The survey also included a fourth building more than a mile from the tower to serve as a control.

Other types of interference included buzzing in the ears and music emanating from interior walls, air conditioners and gold teeth. Also, radio broadcasts were recorded onto tape and video recorders and telephone answering machines.

The May 27 *Honolulu Advertiser* reported that one resident of the Villa on Eaton Square, one of the buildings surveyed, had gone through four answering machines in the hope of finding one that does not pick up spurious radio signals. On occasion, she returned home to find that, instead of her phone messages, she had a one-hour tape of rock music. She also experienced EMI problems with her stereo, television and electronic organ.

Zoning Changes Recommended

Melton argued that "The survey results leave little doubt that the phenomena being reported are caused by radiofrequency radiation and give sufficient information to initiate changes in land use policies regarding broadcast towers."

Melton recommended that federal standards be set for siting radio and television transmitters to reduce both potential health risks and EMI and called for a retrospective health study of "as many persons as possible who have lived and/or worked for significant periods of time near sources of radiofrequency radiation." He also urged local, state and federal officials to form a task force "to work out a consensus solution to the existing radiofrequency radiation problems."

In releasing the survey results in early June, Bornhorst supported the report's recommendations. She said that the data provide "sufficient evidence" that Honolulu's zoning code should be changed to distance broadcast towers from areas where people live and work. Zoning rules currently prohibit siting transmitter towers on the hills surrounding the city, forcing broadcasters to place them in the city.

EPA-FCC Survey

In May 1984, Richard Tell of the Environmental Protection Agency (EPA) and Dr. Robert Cleveland of the Federal Communications Commission (FCC) measured levels as high as 306 mW/cm^2 next to the access-limiting fence at the Ala Wai tower. In a recreational area on the roof of the Villa on Eaton Square, they found AM levels greater than 24 mW/cm^2 (see *MWN*, January/February 1985).

In a press release accompanying Melton's report, Councilmember Bornhorst expressed alarm that the EPA-FCC measurements contrasted sharply with the agencies' press statements that residents near the tower are in no immediate danger. "How can they say that when they knew about the danger of burns, they know that there is an epidemic of birth defects in Vernon Township (another 'hot spot'), and they know of long-term studies that show it causes cancer in laboratory animals," she said.

For a copy of the report, *Survey of Phenomena Experienced by Residents Living Close to the Ala Wai Broadcasting Tower, Honolulu, Hawaii* (June 1985), contact: Councilmember Marilyn Bornhorst, City Council, Honolulu, HI 96813, (808) 523-4000.

Florida Panel Discounts Power Line Bioeffects

The Florida Electric and Magnetic Fields Science Advisory Commission (SAC) has concluded that "It is unlikely that human exposure to 60 Hz electric and magnetic fields can lead to public health problems." The one-year,

$200,000 study was funded by the Florida Electric Power Coordinating Group (FCG), a consortium of state electric utilities, for the Florida Department of Environmental Regulation (DER).

The only adverse environmental effects associated with 230-or-greater kV transmission lines are the potential for pacemaker interference and shocks to honeybees living in hives under the lines, according to the SAC report.

The panel noted that "Adverse public health effects of such fields have not yet been established," but that "Because of certain ambiguities in the currently available scientific information, further developments in the area should be monitored." However, the panel added: "Once an initial decision has been made in Florida that public health problems are unlikely, reopening the area for further consideration would not be justified unless a significant new body of experimental evidence becomes available."

The SAC also concluded that "there is not currently sufficient evidence to allow the scientifically based choice of a measure of exposure to electric and magnetic fields that could be used as the basis for a program of exposure control."

The 266-page report, *Biological Effects of 60-Hz Power Transmission Lines*, recommends that "Concerned parties ...should urge the Food and Drug Administration to revise pacemaker testing and performance criteria so as to include circumstances representative of transmission line induced currents and appliance leakage currents."

The panel called on state agencies and the electric utilities to inform beekeepers of potential risks to their bees and of ways to eliminate these risks — grounded chicken wire surrounding the hives is sufficient in most cases.

The SAC was formed by the FCG as an independent source of scientific expertise to the DER. The department had been charged with responsibility for assessing potential health hazards of transmission lines and, if necessary, for promulgating safety regulations, as a result of legislation passed in 1983 following siting disputes (see *MWN*, July/August 1983 and July/August 1984). Despite its apparent link to the utilities, the commission's report explains that the panel operated at "arm's length" from the utilities and that the DER is not bound by the SAC's recommendations.

The commission was chaired by Professor H.B. Graves of the Pennsylvania State University in University Park, who also chaired a study on the Navy's Project ELF, which similarly concluded that the ELF fields would be "unlikely" to pose a health or environmental problem (see *MWN*, May 1985).

Other SAC members were: Dr. T. Dan Bracken of Scientific Research and Consulting Services in Portland, OR; Dr. Jerry Griffin of the University of California in San Francisco, CA; Dr. John de Lorge of the Naval Aerospace Medical Research Lab in Pensacola, FL; Dr. M. Granger Morgan of Carnegie-Mellon University in Pittsburgh, PA; and Dr. Tom Tenforde of the Lawrence Berkeley Laboratory in Berkeley, CA.

For more information, contact the FCG's Ron Spika, 402 Reo St., Suite 214, Tampa, FL 33609, (813) 877-5301. The report is available from the National Technical Information Service (NTIS), Springfield, VA 22161, (703) 487-4650.

CONFERENCES

September 9: **Biological Effects of Electropollution: Brain Tumors and Experimental Models,** Howard University Inn, Washington, DC. Contact: Electropollution Symposium, PO Box 83, Howard University Administration Bldg., Washington, DC 20059, (202) 636-6933.

September 9-12: **15th European Microwave Conference,** Paris, France. Contact: Microwave Exhibitions & Publishers Ltd., Convex House, 43 Dudley Rd., Tunbridge Wells, Kent TN1 1LE, UK.

September 10-12: **7th Annual Electrical Overstress/Electrostatic Discharge Symposium,** Radisson South Hotel, Minneapolis, MN. Contact: Michael Martin, 3M/Static Control Div., 2111 W. Braker Lane, Bldg. 501, PO Box 2963, Austin, TX 78769, (512) 834-3117.

September 12-14: **1st Annual Clinical Hyperthermia Symposium and Workshop,** St. Louis, MO. Contact: Dr. B. Emami, Division of Radiation Oncology, Mallinckrodt Institute of Radiology, 4511 Forest Park Blvd., Suite 311, St. Louis, MO 63108, (314) 362-3470.

September 23-26: **4th International Conference on AC & DC Power Transmission,** London, UK. Contact: Institution of Electrical Engineers (IEE), Savoy Place, London WC2R 0BL, UK, (01) 240-1871.

September 27-30: **7th Annual Conference of the IEEE Engineering in Medicine and Biology Society,** Americana Congress Hotel, Chicago, IL. Contact: Dr. Barry Feinberg, Kendall Co., 411 Lake Zurich Rd., Barrington, IL 60010, (312) 381-0370. Followed by September 30-October 2: **38th Annual Conference on Engineering in Medicine and Biology,** Chicago, IL. Contact: Susan Leone, ACEMB, 4405 East-West Hwy., Suite 402, Bethesda, MD 20814, (301) 657-4142.

October 3-5: **2nd Congress of the European Society of Magnetic Resonance in Medicine and Biology,** Montreux, Switzerland. Contact: Dr. M.A. Hopf, 1 route de Florissant, CH-1206 Geneva, Switzerland, (41)(22) 472547.

October 7-9: **1985 International Geoscience and Remote Sensing Symposium,** University of Massachusetts, Amherst. Contact: Professor Calvin Swift, Dept. of Electrical and Computer Engineering, University of Massachusetts, Amherst, MA 01003.

October 13-17: **5th International Meeting of the Bioelectrical Repair and Growth Society,** Park Plaza Hotel, Boston, MA. Contact: Dr. S.R. Pollack, University of Pennsylvania, 119 Towne Bldg., 220 South 33rd St., Philadelphia, PA 19104, (215) 898-8241.

October 15-18: **Phased Arrays 85,** Bedford, MA. Contact: Dr. Hans Steyskal, RADC/EEA, Hanscom AFB, MA 01731, (617) 861-2052.

October 21-24: **1985 Conference on Electrical Insulation and Dielectric Phenomena,** Marriott Hotel, Amherst, NY. Contact: Steven Boggs, Ontario Hydro, 800 Kipling Ave., Toronto, Ontario M8Z 5S4, Canada, (416) 231-4111, ext. 6735.

November 5-6: **1985 Producibility of Microwave and Millimeter Integrated Circuits Conference,** Redstone Arsenal, AL. Contact: Joe Derie, U.S. Army Missile Command, Attn.: AMSMI-EE, Redstone Arsenal, AL 35898, (205) 876-8421.

November 5-7: **Review of Contractors Research on the Biological Effects of Electric and Magnetic Fields Associated with High Voltage Transmission Lines,** Radisson Mark Plaza Hotel, Alexandria, VA. Contact: Dr. William Wisecup, Aerospace Corp., Suite 4000, 955 L'Enfant Plaza, SW, Washington, DC 20024, (202) 488-6328.

EXCERPTS

NIOSH Draft Occupational RF/MW Exposure Standard

Reprinted below are excerpts from the occupational radiofrequency and microwave (RF/MW) radiation exposure standard proposed by the National Institute for Occupational Safety and Health (NIOSH) in the external review draft of its criteria document. The draft document was released at the annual meeting of the Bioelectromagnetics Society in San Francisco, CA, in June. *See story on pp.2-3.*

Explanations and Limitations of REL Usage

The explanations and limitations of recommended exposure limit (REL) usage are an integral part of the recommended Occupational Exposure Standard. It is essential to understand these explanations and limitations prior to determining compliance with this standard.

1. The RELs apply to both partial and whole-body exposures unless the provisions given in the section on "Exclusions from REL Usage" can be met.

2. All mean squared electric field strength (E^2), mean squared magnetic field strength (H^2) and equivalent plane-wave power density values shall be determined by free-space measurements (i.e., under exposure conditions in which *no part of the worker* is in contact with an electrically conductive surface whether or not the surface is grounded).

3. From 300 kHz to 300 MHz, measurement of both mean squared electric field strength (E^2) and mean squared magnetic field strength (H^2) is required for compliance. Measurement of equivalent plane-wave power density is not permitted for compliance at frequencies from 300 kHz to 300 MHz.

4. Above 300 MHz, measurement of either mean squared electric field strength (E^2), mean squared magnetic field strength (H^2), or equivalent plane-wave power density is sufficient for compliance.

5. RELs apply to both pulsed wave (PW) and continuous wave (CW) RF radiation exposures. For pulsed RF radiation sources, the average of the mean squared electric field strength, mean squared magnetic field strength or equivalent plane-wave power density is calculated by multiplying the peak pulse value of the mean squared field strength or power density by the duty cycle. The duty cycle is equal to the pulse duration in seconds multiplied by the pulse repetition rate in cycles per second.

6. All mean squared field strength and equivalent plane-wave power density measurements can be time averaged over any 6-minute period for comparison with RELs. This provision applies to CW exposures and to the average of the mean squared field strength and power density values for PW exposures.

7. For mixed or broadband fields consisting of several frequencies for which there are different REL values, the fraction of the REL incurred within each frequency range shall be determined, and the sum of all such fractions shall not exceed unity.

8. Measurements to determine compliance with the standard shall be made at distances of 5 cm or greater from any object.

9. This standard is not intended to apply to the purposeful exposure of patients by or under the direction of practitioners of the healing arts.

10. Exposure conditions which will cause an involuntary response (startle reaction) due to an RF shock or current flow are not permitted from 300 kHz to 300 GHz. In addition, exposure conditions which will cause an RF burn are not permitted from 300 kHz to 300 GHz. These restrictions apply even if the exposure limits of this standard are not exceeded. Shock and burn hazards can be controlled through the use of insulated gloves, shoes and other protective clothing; by insulating the RF source and conducting objects within the RF field; by using proper grounding techniques; or by eliminating the possibility of worker contact with the source or with conducting objects in the field. Extra precautions should be taken around long conductive objects such as wires, cables and cranes and around large ungrounded objects such as cars, trucks and buses when these objects are in close

NIOSH Draft RF/MW Exposure Limits

Frequency Range	Equivalent Plane-Wave Power Density (mW/cm^2)	Mean Squared Electric Field Strength (V^2/m^2)	Mean Squared Magnetic Field Strength (A^2/m^2)
0.3-3 MHz	50	188,500	1.33
3-30 MHz	$450/f^2$	$3{,}770(450/f^2)$	$0.027(450/f^2)$
30-300 MHz	0.5	1,885	0.013
300 MHz-3GHz	f/600	3,770(f/600)	0.027(f/600)
3 GHz-300 GHz	5	18,850	0.133

Note: f = frequency in MHz.

proximity to high power RF sources such as AM and FM broadcast antennas. The proper control measures for a particular exposure condition vary. Each case must be carefully analyzed to determine the optimum method of preventing RF shocks or burns.

11. These RELs and associated explanations, limitations and exclusions apply under all environmental conditions regardless of ambient air temperature, relative humidity, air velocity or the radiant energy input at frequencies higher than the frequency range of this recommended standard.

Exclusions from REL Usage

These exclusions from REL usage are an integral part of the recommended standard. It is essential to understand and correctly apply this information when claiming exclusions from REL usage during compliance determinations.

1. For frequencies from 300 kHz to 30 MHz, the RELs may be exceeded if it can be demonstrated that the average whole-body SAR does not exceed 0.2 W/Kg, that the spatial peak SAR does not exceed 5 W/Kg as averaged over any one gram of tissue and that RF burns and startle reactions do not occur. However, exposures greater than 50 mW/cm^2 (188,500 V^2/m^2, 1.33 A^2/m^2) will not be permitted for continuous exposures longer than 6 minutes, even if the above conditions are met.

2. For frequencies above 30 MHz, the RELs may be exceeded if it can be demonstrated that the average whole-body SAR does not exceed 0.2 W/Kg, that the spatial peak SAR does not exceed 5 W/Kg as averaged over any one gram of tissue and that RF burns and startle reactions do not occur.

VLF and RF Radiation Risks *(continued from p.1)*

Burns and Shocks

In a paper presented at the *7th Annual Meeting of the Bioelectromagnetics Society (BEMS)* held in San Francisco, CA, June 16-20, Gandhi reported that "the currents flowing through the hand of a human in conductive contact with the handle of an ungrounded van can be as high as 879 mA and produce a local SAR in the wrist of about 1045 W/Kg." This experiment was run at 3 MHz at 100 mW/cm^2.

With respect to ways of protecting workers in such electrical environments, Gandhi reported that "electrical safety shoes and gloves provide adequate protection from induced currents up to about 1 MHz."

The Utah research is an extension of ongoing work on VLF radiation hazards funded by the U.S. Air Force School of Aerospace Medicine at Brooks Air Force Base in San Antonio (see *MWN,* May and September 1983). In an earlier paper, Gandhi reported that the electric fields associated with 100 mW/cm^2 300 kHz-3 MHz fields — exposure levels allowed under the 1982 ANSI guidelines — could cause RF burns (see *Proceedings of the IEEE, 70,* 1462-1464, December 1982).

Gandhi's VLF results have been generally confirmed by Professor Bill Guy at the University of Washington in Seattle, whose work was also funded by the Air Force. Both Gandhi and Guy have found that VLF radiation can cause hot spots in the wrist.

According to William Hurt, the Air Force project officer for both studies, final reports on the studies should be available soon.

ANSI Standard Will Need Revision

In his talk at the BEMS meeting, Gandhi said that the 1982 ANSI guidelines are "clearly too high for the general population."

Similarly, in reviewing his VLF findings, Guy told the audience that the new results will require a change in the ANSI standard.

The new hot spot and body current data are likely to add fuel to the ongoing debate on the safety of human exposure to radiation from radio, television and high frequency transmitters (see *MWN,* May 1985). In Honolulu, HI, for example, measurements by the Environmental Protection Agency and the Federal Communications Commission found AM radiation (550 kHz-1.6 MHz) levels as high as 3,054 mW/cm^2 (see story p.6). Gandhi's data could also have an impact in the 54-88 MHz band, used for television broadcasting.

The findings could also increase awareness of the health risks to those who use RF energy in industry. Of special concern are workers who use RF heaters and sealers, which operate in the 3-100 MHz frequency band.

While many of the BEMS attendees agreed with the Gandhi and Guy opinions that the ANSI standard needs immediate review in light of the new data, Subcommittee IV on "Safety Levels and/or Tolerances with Respect to Personnel" of the Accredited Standards Committee C95 will not begin considering any changes until next June.

Although the C95.1 standard will continue to be an official ANSI standard, the committee will no longer be an ANSI committee; instead it will be called the Accredited Standards Committee C95. The committee will continue to be sponsored by the IEEE and the U.S. Navy.

At a meeting on June 20 immediately following the BEMS conference, Dr. Kristian Storm of the UCLA School of Medicine, chairman of the C95.IV subcommittee, said that he was aware of the new Gandhi and Guy data and that they are being studied. According to Storm, budgetary and time constraints prevent a meeting before next year, when he plans to hold a two-day session to frame a proposed revision to the 1982 standard. That meeting is tentatively scheduled to coincide with the 1986 BEMS meeting, which will be held June 1-6 at the University of Wisconsin in Madison.

The C95.IV subcommittee meeting was held in the late afternoon after the close of the BEMS meeting, when many of the participants were making their way home. Neither Gandhi nor Guy was able to attend. ●

UPDATES

BIOLOGICAL EFFECTS

Immunology in the U.S.S.R....A group of researchers at the Kiev Institute for General and Communal Hygiene report that low-level exposure to 2375 MHz microwaves first stimulates and then depresses the immune system. Rats exposed to power densities of 10-50 uW/cm^2 experience a "strain on the energy metabolism processes occurring in neutrophils over the course of three weeks of irradiation." (Neutrophils are leukocytes.) A translation of "Immunological and Hematological Effects of Low Intensity SHF-Band Electromagnetic Fields" by G.I. Vinogradov and coworkers appears in *Biological Effects of Non-Ionizing Electromagnetic Radiation* (Vol.8, No.3, June 1984). See below.

Bibliographies... The Office of Naval Research has released three new volumes in its series, *Biological Effects of Non-Ionizing Electromagnetic Radiation:* Vol.8, No.3 (June 1984), Vol.8, No.4 (September 1984) and Vol.9, No.1 (December 1984). The last volume contains a complete translation of the abstracts of the papers presented at the *All-Union Symposium on the Biological Effects of Electromagnetic Fields,* held in Pushchino, U.S.S.R. in 1982. A limited number of copies of each volume are available from the Office of Naval Research, Code 441, Arlington, VA 22217 (include a mailing label)....The U.S. Air Force has released the fifth volume in its continuing collection of the RF/MW literature, *USAFSAM Review and Analysis of Radiofrequency Radiation Bioeffects Literature* (USAFSAM-TR-85-7). This edition contains a critical look at 40 papers and a cumulative index of the 200 papers reviewed in the 5 volumes issued to date. The reviews were written by Louis Heynick and Dr. Peter Polson of SRI International in Menlo Park, CA. Copies are available from the National Technical Information Service (NTIS), Springfield, VA 22161.

Honeybees and Power Lines... Honeybee colonies near power lines can suffer adverse effects, according to an EPRI study conducted by Bernard Greenberg and Vytas Bindokas, of Bioconcern and the University of Illinois at Chicago, and James R. Gauger, of the IIT Research Institute, also in Chicago. Hives were placed at varying distances from a 765-kV line so that they were exposed to electric fields ranging from 0.65 to 7 kV/m; half of the hives were shielded to provide controls. At 4.1 kV/m, the researchers found reduced hive weight and lower propolization (deposit of resinous material collected from tree buds), and at 5.5 kV/m, they noted loss of queens and impaired foraging, indications of serious damage to a colony. At 7 kV/m, fields inside the hive reached 100 kV/m, and shock currents were as high as 500 nA. At the DOE-EPRI-NY State contractors' meeting held in St. Louis on November 7, 1984, the researchers indicated that their data "suggest that colony disturbance under a 765-kV transmission line is not a direct E-field effect, but rather the result of shocks from induced-hive or bee-body currents." A forthcoming report will describe the results of a full-scale study that exposed hives and matched controls to field or shock currents independently. The report, "The Effects of High-Voltage Transmission Lines on Honeybees" (EPRI EA-3898, Interim Report), was published in May 1985 and is available for $11.50 (prepaid) from Research Reports Center, PO Box 50490, Palo Alto, CA 94303, (415) 965-4081. (See also their earlier report, EPRI EA-1809, with the same title, dated April 1981 and pp.6-7.)

Manipulating Genes with Electricity... High voltage electrical pulses can induce the introduction of foreign DNA into plant cells — a finding that could play an important role in the genetic engineering of plants. William Langridge, of the Boyce Thompson Institute for Plant Research in Ithaca, New York, and Bao-Jian Li, of the Cunshang University in China, applied short pulses of 40-volt DC to a mixture of bacterial plasmid (extrachromosomal DNA rings) and enzyme-treated carrot cells. About 2 percent of the carrot cells took up and expressed the bacteria DNA, a number 20,000 times greater than would occur without using the technique, called electroporation. The pulses open up the carrot cell membrane, allowing the entry of the foreign DNA. Current methods for introducing foreign DNA into plant cells are difficult and limited. Electroporation may one day allow any gene to be directly introduced into plant cells. See "Zapping DNA Into Plant Cells" in the July 13 *Science News*.

COMMUNICATIONS

An Alternative to Satellites... Soviet researchers are experimenting with powerful electromagnetic pulses to create plasma clouds of charged particles in the ionosphere to reflect TV and radio signals. This technique could possibly lead to an alternative to satellites, according to a December 20, 1984 report from TASS, picked up by the *Review of International Broadcasting* (Issue No. 100, released in June). With careful aiming, the reflected signals can be directed to specific spots on the Earth's surface. The U.S. is also involved in research of this type, though much of it is classified because of its potential application to military communications. For a review of some of the ongoing research, see the collection of papers on "Ionospheric Effects on Radio Systems" in the May-June 1985 issue of *Radio Science,* Vol.20, No.3.

Cellular Phones: Promise v. Reality... Over the last few years, the public has been promised a revolution in mobile communications with the introduction of cellular telephones — already available in 60 U.S. cities, with more to come. It turns out that the promise was greater than the reality. A series of press reports at the end of June noted that the demand for cellular phones is softer than expected and the cost of providing service is more than $2,500 per subscriber. In addition to the marketing problems, the technology may not be working up to expectations. The system was originally hailed as an ingenious way of maximizing the efficient use of the frequency spectrum by dividing a region into hexagonal cells so that the same frequency could be re-used in non-adjoining cells, with a computer automatically transferring a call from one fre-

quency to another as a driver moved around the city. Before the introduction of cellular systems, a city had a maximum of 44 channels; New York City, a prime market, could only handle 12 mobile telephones at once. When the FCC authorized cellular service, they increased the number of channels to 666, allowing many more simultaneous calls. But the promise of adding capacity by splitting cells to accommodate demand is proving to be illusory. Indeed the present capacity is due only to the new FCC allocation, not to the new technology, and the cellular phone companies are in the process of going back to the FCC to ask for more spectrum space. As Andrew Pollack reported in the June 20 *New York Times*, "As the cells get smaller and closer together, coordination among different cells becomes more complex and interference more troublesome....What was pictured in theory as a nice honeycomb pattern of hexagonal cells is turning out to be more of a haphazard jumble of amoeba-shaped cells. As the pattern deviates from the optimal, overall system capacity and quality of service degrade as well." One problem is the resistance of local residents to the siting of antennas in urban areas.

COMPATIBILITY & INTERFERENCE

Woodpecker Watch... Shortwave listeners in North America have organized "The Woodpecker Project" in an effort to force the Soviet Union to control interference caused by its over-the-horizon (OTH) radar system. Coordinated by the Association of North American Radio Clubs' (ANARC) OTH Committee, the Woodpecker Project plans to ask representatives at the 1987 World Administrative Radio Conference (WARC) for High-Frequency Broadcasting to object formally to the Soviet OTH interference, which produces a "pecking" sound. To support this position, organizers of the project are recruiting volunteers to help monitor shortwave frequencies from 5-23 MHz for Woodpecker interference 24 hours a day for a total of 5 days in October; each volunteer will be asked to monitor a 3 MHz band for 3 hours. The Soviet OTH radar uses a 3 to 4 millisecond square-wave pulse with a repetition rate of 10 pulses per second, according to the project, which recently noted that the radar has been operating around 10.7 MHz. For more information, contact Robert Horvitz c/o Woodpecker Project, 1634 15th St., NW, Washington, DC 20009.

Aircraft Generated EMI...NASA is about to undertake a research program to understand and control EMI aboard aircraft. The agency is soliciting bids for the collection of data on conducted and radiated interference to digital circuits — with special attention to fast rise-time transients. One of the goals of this effort is to update existing FAA rules for the safe and compatible use of modern electronic technology. NASA had been negotiating with Chris Kendall Consultants of Mariposa, CA, on a sole-source basis, but opened up the bidding when other parties expressed an interest in the project. The closing date for responses to Solicitation No. RFP2-31865(JAC) is August 8. For more information, contact NASA's Joanne Comstock, NASA Ames Research Center, Moffett Field, CA 94035, (415) 694-5786.

EMI Survey... Frost & Sullivan, an international market research firm, is preparing a study for fall release on the U.S. market for EMI and RFI test equipment. As part of the project, the company has distributed a four-page survey questionnaire to specialists in the field. For more information, contact Raymond Cappiello, Project Director, 73 Hudson Rd., Bellerose Village, NY 11001, (516) 437-4335.

GOVERNMENT

Radiation Research Proposals... Bills have been introduced in both houses of Congress that would shift the responsibility for research on *ionizing* radiation bioeffects from the Department of Energy (DOE) to the Department of Health and Human Services (HHS). The "Radiation Research Reorganization Act" (H.R.1287), introduced by Representative Tim Wirth (D-CO) on February 26, and the "Radiation Reorganization Act" (S.525), introduced by Senator John Glenn (D-OH) on February 27, are virtually identical. Because the DOE is presently charged with the potentially conflicting roles of studying the health effects of radiation and producing and using nuclear materials, some members of Congress have raised questions about the objectivity of its bioeffects research efforts. Although the two bills apply specifically to ionizing radiation, they could open the door to a similar change for ELF (power line) radiation research, presently administered by the DOE's Electric Energy Systems Division. H.R.1287 was referred to both the House Energy and Commerce Committee's subcommittee on health and environment and the House Science and Technology Committee's subcommittee on science research and technology. Glenn's S.525 was referred to the Senate Committee on Government Affairs' subcommittee on nuclear proliferation and government processes. Glenn introduced a similar bill in 1982, S.2284, which would have set up two interagency panels to coordinate research and regulations for ionizing and non-ionizing radiation (see *MWN*, May and June 1982). That bill died in committee.

Cable Leakage Rules Reaffirmed... The FCC has reaffirmed, with minor modifications, its revised Part 76 rules for protecting aeronautical navigation and communications radio services from cable TV leakage interference. The commission argued that "reduced signal leakage is the

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only long-term solution to the problem of interference." In a June 21 "Memorandum Opinion and Order" (50 *Federal Register* 29394, July 19), the FCC denied seven petitions for reconsideration of its rules, which were issued last November (see *MWN*, December 1984), but approved a request to delay for 5 years the mandatory use of a signal-leakage criteria test (the "Cumulative Leakage Index") by cable operators. Other revisions include: (1) the adoption of a 100 microwatt "universal trigger level for FCC notification" for new aeronautical frequencies; and (2) the determination of this threshold level will now use *average* power across a 25 kHz bandwidth in any 160 usec period, rather than *peak* power, as originally required. This latter change was requested by the National Cable Television Association. For more information, contact the FCC's Freda Lippert Thyden at (202) 632-7792 for legal concerns and the FCC's Bernard Gorden at (202) 632-9660 for technical matters.

FCC Enforcement Actions...FCC officials interrupted the start of a corporate liquidation auction because computers that did not meet the commission's RF emissions rules were among the items up for grabs, according to *The Washington Post* (July 25). Seequa Computer Corp., based in Odenton, MD, sold inadequately shielded computers as long ago as last October, a commission spokesman told the newspaper. After some discussion between company and federal representatives, the auction began and the computers were sold — although the purchasers will have to wait at least 4-6 weeks for the FCC to complete lab tests on the units....The FCC has fined three cordless phone manufacturers $2,000 each for selling cordless phones that exceed the commission's standards for radiated power emissions. Under a new sampling procedure that uses commercially available phones rather than prototypes (see *MWN*, November 1984), FCC staffers measured field strengths up to five times as high as the commission's maximum permissible limit of 10,000 uV/m at 3 meters. Matsushita Technology, Pacific Electronics Programs and Webcor Electronics were fined after failing to correct the violations despite warnings from the commission. The FCC fined three distributors of cordless phones for similar violations last January (see *MWN*, January/February 1985)....In another action, the commission has decided to require cordless phone manufacturers to label their products with warnings about the potential problems of RFI and inadequate security — including the use of one's phone by an outside party and inadvertent interaction with other nearby cordless phones. Beginning on November 1, manufacturers will have to describe their phones' security features to purchasers (50 *Federal Register* 24512, June 11). The FCC noted that the Association of Public-Safety Communications Officers (APCO) has been plagued with "drop off" calls to 911 emergency systems — no one is on the line when the call is answered. APCO has traced many of these calls to cordless phones. The FCC has taken no action on this interference problem but promises to reconsider the problem if it persists.

CDRH Reporting Review... The FDA's Center for Devices and Radiological Health (CDRH) has issued a public review draft of its "Report of the CDRH Task Force for Retrospective Review of the Recordkeeping and Reporting Requirements of 21 CFR 1002" (50 *Federal Register* 27024). The task force, set up in 1982 in response to a congressional directive requiring regulatory flexibility (see *MWN*, December 1982), recommends that manufacturers of radiation-emitting products be permitted to file less documentation than now required to prove that they are complying with CDRH regulations. In addition, the task force suggests, the types of reports required should be modified and streamlined. Comments on the recommendations are due by August 30. For more information, contact Melvyn Altman, CDRH (HFX-83), FDA, 5600 Fishers Lane, Rockville, MD 20857, (301) 443-3426.

LITIGATION

Yannon Hearing... Mrs. Antoinette Yannon's $3.5 million product liability suit against RCA for the wrongful death of her husband, Samuel Yannon, due to long-term exposure to microwave radiation, is going back to court. A hearing will be held on September 10 in the state Supreme Court in Staten Island, NY. In July 1982, a Supreme Court judge dismissed the case, but the decision was reversed on appeal (see *MWN*, June 1984). Guy Lawrence of the New York City law firm of Bower & Gardner, which is representing RCA, refused to comment on any aspect of the case. A spokesman for RCA confirmed the September 10 hearing date. Yannon worked on microwave relay equipment at the Empire State Building for 15 years. He retired from New York Telephone in 1971 and died in 1974.

Loesch Dies... Andrew Loesch, a former FAA radar technician who filed a $1.5 million suit against the FAA, claiming he developed a brain tumor from exposure to microwave radiation, died on July 23 (see *MWN*, May 1985). His attorney, Michael Allison of DeLayo and Olson in Albuquerque, NM, told *Microwave News* that the FAA denied the Loesch claim on July 19 and that a workers' compensation claim will be filed on behalf of Loesch's widow, Katherine. Allison said that he is still evaluating whether to file a suit against the manufacturers of the radiation-emitting equipment.

MEASUREMENT

NBS Report... Three members of NBS's Electromagnetic Fields Division have prepared a report, *Possible Estimation Methodologies for Electromagnetic Field Distributions in Complex Environments (Technical Note 1081)*, which outlines three ways of approximating field strengths when there are multiple sources operating at different frequencies. M. Kanda, J. Randa and N.S. Nahman outline the approaches: a statistical treatment, a numerical computation and the use of a directional probe. While the methods are still under development, the researchers expect them to help in the prediction of maximum field strengths inside buildings housing sensitive electronic and ordinance equipment and thereby prevent interference problems. The

report is available for $2.00 from the Government Printing Office, Washington, DC 20402. Order No. 003-003-02638-7.

MEDICAL APPLICATIONS

Diathermy and Low Back Pain...A placebo treatment for low back pain proved to be as effective as short-wave diathermy (SWD) or osteopathy in a study by researchers at Guy's Hospital in London. T. Gibson and coworkers at the Department of Rheumatology randomly divided 109 patients who had suffered low back pain for 2-12 months into 3 groups: one was treated with SWD, a popular therapy for low back pain, another was treated by an osteopath (chiropractor) and the third was treated with an unplugged SWD unit that appeared to be functioning. 8 weeks after 4 weeks of treatment (3 times weekly with the active or inactive SWD, once weekly by the osteopath), 59 percent of those treated with SWD reported improvement, as did 62 percent of those treated with osteopathy and 67 percent of those treated with the detuned SWD; 12 percent of the patients who received SWD noted a worsening in their condition, as did 11 percent of those treated with osteopathy and 9 percent in the placebo group. Although the authors report that their study "does not indicate that SWD and osteopathy are equivalent to no treatment," they do conclude that "our results almost certainly attest to the magnitude of the placebo response which may be achieved when harmless treatments are applied with conviction." The study, "Controlled Comparison of Short-Wave Diathermy Treatment with Osteopathic Treatment in Non-Specific Low Back Pain," appeared in the June 1 issue of *Lancet*.

MEETINGS

Power Line Contractors... The date for the DOE-EPRI-NY State contractors' meeting, *Review of Contractors Research on the Biological Effects of Electric and Magnetic Fields Associated with High Voltage Transmission Lines*, has been officially set for November 5-7 at the Radisson Mark Plaza Hotel in Alexandria, VA, (703) 845-1010 or (800) 228-9822. There will also be two workshops, one on dosimetry on November 4 and one on mechanisms on November 8, but these sessions will be restricted. When making hotel reservations, mention "DOE Contractors Review" to get a reduced rate. For more information, contact Dr. William Wisecup, Aerospace Corp., Suite 4000, 955 L'Enfant Plaza, SW, Washington, DC 20024, (202) 488-6328.

1986 Gordon Conference...A Gordon Conference is being planned for the week of June 8-13, 1986 in New Hampshire to discuss the biophysical and biochemical effects of electromagnetic fields that can influence growth and excitation processes. The registration fee will be approximately $250, including room and board. The conference follows the annual meeting of the Bioelectromagnetics Society, which will be held in Madison, WI, next year. For more information, contact Professor Howard Wachtel, University of Colorado, Boulder, CO 80309, (303) 492-7327, or Professor Betty Sisken, University of Kentucky, Lexington, KY 40506, (606) 258-5796.

EMI for Non-EMIers...R&B Enterprises is introducing a new short course, *EMI for Non-EMI Personnel*, to provide an overview of the "basic hows and whys of EMI/EMC" for those "who want to feel more secure and confident when discussing EMI/EMC." The one-day course will be offered in Philadelphia, PA on October 10. The fee is $345. Additional details from: Greg Gore, R&B Enterprises, 20 Clipper Road, West Conshohocken, PA 19428, (215) 825-1960.

MILITARY SYSTEMS

Effect of Standards... In April 1985, NATO's Advisory Group for Aerospace Research and Development (AGARD) hosted a series of two-day lectures in Lisbon, Paris and Rome on *The Impact of Proposed RF Radiation Standards on Military Operations* (AGARD Lecture Series No. 138). The invited speakers were John Mitchell, Col. Roger Graham and Dr. Jerome Krupp of the U.S. Air Force, Dr. Carl Durney of the University of Utah, Dr. Bill Guy of the University of Washington, Dr. Norbert Roberts of the University of Rochester and Dr. J. Bernhardt of the Institute for Radiation Hygiene in West Germany. Dr. Tom Rozzell of the Office of Naval Research attended the Lisbon lectures and summarized them for the June/July issue of the *Bioelectromagnetics Society Newsletter*. The following is based on Rozzell's report: Krupp reviewed the results of the long-term, low-level exposure study conducted by Guy for the Air Force: "The overall conclusion was that no cumulative ill effects could be attributed to the life-long exposure at absorption rates of 0.4 W/Kg or less." Krupp is the project officer for the study (see *MWN, July/August 1984, March and June 1985*). Krupp told the audience, "Rational review of the existing data provides no reason to predict adverse consequences from lifespan exposure to currently allowable levels of RF radiation." Graham discussed incidents of accidental overexposures to RF energy. He said, "In every case where the exposed person was an Air Force employee...they are kept under medical surveillance throughout their lives in order to detect any harmful effects that might develop." But, Graham added, medical examinations of those overexposed "have shown few, if any, consistent clinical patterns." Neurological and psychological exams have also failed to indicate any trends — except for anxiety in cases where the individuals have been concerned over their exposure. The full texts of the lectures are available from the National Technical Information Service (NTIS), Springfield, VA 22161.

National Communications Systems Expansion... The Defense Communications Agency (DCA) and the Air Force (AF) have announced plans to construct a Northeast Regional Communications Facility (NRCF) in western Massachusetts, but citizens and elected officials are resisting the proposal. The project was first described in a notice of intent to prepare a draft environmental impact statement (EIS) published in the *Federal Register* on March 28 (50

FR 12360). But most citizens in Hawley, MA, where as many as 40 transmitter towers and one microwave receiver would be sited, first learned of the project on May 15, when AF officials held a public meeting there; a second meeting was held the next day in nearby Granby, MA, near the Westover Air Force Base where the operations and receiver facilities are planned. Angered when the AF informed them that the formal comment period ended on June 1, citizens contacted their Congressman, Silvio Conte, who persuaded AF officials to extend the deadline to July 1. Conte, who, as the ranking Republican on the House of Representatives' Committee on Appropriations, wields considerable influence over the funding of the $22.7 million project, subsequently vowed to block the project after he learned that no money has yet been appropriated for it. And officials of Franklin County, which contains Hawley, have hired the Boston law firm of McGregor, Shea & Doliner to represent them in their fight to block the system. An AF spokesman confirmed that the Pentagon will proceed with development of the project, including preparation of an EIS, but added that the scope of the EIS will be expanded to consider alternatives to the Hawley site. He admitted that this change was made "because of what Conte said." A two-page background paper and a four-page proposal summary, prepared by the AF before Conte became involved, explain that the Hawley-Westover AFB sites are clearly the best alternatives and that failure to construct the NRCF would "significantly increase the risk of potential damage and/or embarrassment to the U.S. government because of delays in communications which implement/effect actions and strategies as means of implementing U.S. government policies." According to the documents, the NRCF would operate between 3 and 30 MHz with an average power output of 10 kW and a maximum average of 20 kW. The 20-watt microwave link between the Hawley site and Westover AFB will operate in the 1800 MHz band. The draft EIS is due to be completed by the late summer or early fall and the final EIS is planned for early 1986; the AF's spokesman conceded that the expanded scope could delay completion. The AF hopes to begin construction on the project in 1986 and to start operating the facility in mid-1987. For more information, contact: Major Ken Small, USAF/LEEV, Bolling AFB, Washington, DC 20332, (202) 767-4156.

OVENS

Appliance Standards... The U.S. Court of Appeals for the District of Columbia has ruled that the DOE must reconsider its 1982 decision not to set efficiency standards for major appliances, including microwave ovens. The July 16 ruling is a legal victory for a coalition of consumer groups and state governments that has sought a federal efficiency standard since the DOE concluded that such standards could not be economically justified given the potential energy savings (see *MWN*, January/February 1983). Industry officials are concerned that the addition of federal standards to the existing patchwork of state rules will cause havoc. Jack Langmead, vice-president of the Gas Appliance Manufacturers Association, told *The Washington Post* (July 17), "What we need is a single national standard to straighten out this massive confusion."

POWER LINES

Planning a Power Line...A new Oregon-to-California 330-mile transmission line is not scheduled to begin construction for another two years or to be turned on until 1990, but planning for the $400 million project is well under way. 34 public meetings were held in May to identify public concerns in an effort to select a suitable corridor for the power line. The California-Oregon Transmission Project (COTP) is being managed by the Transmission Agency of Northern California, with the participation of the federal government, state agencies, and municipal and investor-owned utilities in California. The COTP plans to build a 500 kV AC transmission line and new substations and to upgrade an existing 230 kV line to 500 kV so that California and the Pacific Northwest can sell and exchange power. (The Transmission Agency, composed of 15 publicly-owned electric utilities, was set up by the state of California in 1984 to develop a power line "in an environmentally and economically sound manner.") Six public workshops were held in July to discuss the siting of the line. After further public review in November, an environmental impact statement will be prepared, due for completion by May 1986. Laura Edlin, public affairs director for the project, told *Microwave News* that public involvement is "critical" to the planning of the line. The project is publishing a newsletter to keep interested parties informed. Contact the COTP, PO Box 660970, Sacramento, California 95866....Meanwhile, a feud is brewing as Bonneville Power increases the price Californians must pay for electricity imported over the Pacific Intertie, an existing power line connecting Oregon and California. Much of the new cost stems from the ill-fated nuclear reactors of the Washington Public Power Supply System. For details, see the July 8 *Wall Street Journal*.

STANDARDS

In Finland... The Finnish government's occupational health bureau has issued a proposal to limit exposures to stray RF fields from plastic sealers. Over an eight-hour period, maximum worker exposures would be 60 V/m for electric fields and 0.2 A/m for magnetic fields. For shorter time periods, exposures could exceed these levels up to a one-minute maximum of 300 V/m and 0.8 A/m for electric and magnetic fields, respectively. The proposal, which is available in Swedish and Finnish and which is scheduled to be adopted at the beginning of 1986, is available from the Standards Information Center, NBS, Technology Bldg., Room B166, Washington, DC 20234, (301) 921-2092. Ask for TBT No. 85.73.

C63 Ballots... Subcommittee 1 on Techniques and Developments of the Accredited Standards Committee C63 on EMC has three draft proposals up for a vote: (1) An addition to C63.4 on EMC measurements to include the

"Methods of Measurement of Radio Noise Emissions from Medical Devices" and a proposed addition to either C63.4 or a planned immunity document on "Methods of Measurement of Electromagnetic Immunity of Medical Devices." These proposals are in their third drafts and are dated April 1985 (see *MWN*, June 1984). Ballots are due by July 31. (2) The extension of C63.2 on EMC instrumentation to 40 GHz. At present the C63.2 standard only covers frequencies up to 1 GHz. Ballots on the proposal, dated May 22, are due by August 9. (3) The June 24 revision of C63.12-1984, *Recommended Practice on Procedures for Control of System Electromagnetic Compatibility.* Votes are due by August 30. For more information, contact Fred Huber, Jr., IEEE Standards Office, 345 East 47th St., New York, NY 10017, (212) 705-7960. C63's Subcommittee 1 has scheduled a meeting for August 19, immediately preceding the *IEEE 1985 International Symposium on EMC,* to be held in Wakefield, MA, August 20-22.

Change at ACGIH... Herbert Jones has retired as chairman of the American Conference of Governmental Industrial Hygienists' (ACGIH) Physical Agents Threshold Limit Values (TLV) Committee and has been replaced by David Sliney of the U.S. Army Environmental Hygiene Agency at the Aberdeen Proving Ground in Maryland. Sliney is already a member of the TLV committee and Jones is expected to continue to work with the ACGIH group, which sets standards for exposures to non-ionizing radiation as well as to noise and to heat stress.

Other Developments... The National Electrical Manufacturers Association (NEMA) is seeking comments on its proposed procedure for *Evaluating Ground Fault Circuit Interrupters for Response to Conducted RF Energy,* (February 25, 1985). For more information, contact: Manager, Engineering Dept., NEMA, 2101 L St., NW, Washington, DC 20037....A new standard, *Electrical and Mechanical Characteristics for Terrestial Microwave Relay System Antennas and Passive Reflectors* (ANSI/EIA) 195-C-1985, has been approved by ANSI's Board of Standards Review and should be available soon....The SAE's Committee AE-4 will meet on August 19 in Wakefield, MA, before the IEEE EMC meeting; see above.

ULTRASOUND

More on SCEs... In our April issue, we reported that a group from the University of Rochester had published a paper in *Science* (March 15) announcing that it had failed to replicate earlier findings that diagnostic ultrasound can increase the frequency of sister chromatid exchanges (SCEs), indicating a potential mutagenic and carcinogenic hazard. That paper has now generated two critical comments. Dr. Robert Bases of the Albert Einstein School of Medicine in the Bronx, NY, notes that the initial findings of an increased frequency of SCEs "has been confirmed and extended in publications from five laboratories in the United States and elsewhere." He posits that the mechanism of interaction may be the release of free radicals by pulsed ultrasound. The letter from Bases, who was one of the coauthors of the original SCE paper, appeared in the May 10 issue of *Science*, as did a reply by Drs. Morton Miller and Victor Ciaravino of the University of Rochester. Dr. Alice Martin of the Northwestern University Medical School in Chicago, IL, also wrote to *Science* (July 19), charging that, in their reply to Bases, Miller and Ciaravino had "erroneously present[ed] our work as supporting the hypothesis that ultrasound has no effect on SCEs." Martin reiterated her opinion that "the question of possible bioeffects of ultrasound is still unresolved." (See A.O. Martin, *Journal of Clinical Ultrasound, 12,* 11, 1984.)

VDTs

Workers' Compensation Settlement...A San Francisco, CA, legal writer has received a $15,000 settlement from her former employer's insurance company after filing a workers' compensation claim alleging that VDT use caused her debilitating eyestrain. Five ophthalmologists examined writer Jeanne Robinson and, though none clearly supported her claim, defense attorney Kevin Haney told *Microwave News* that his clients agreed to an out-of-court settlement to "get the thing disposed of." Judge Jane O'Neill of the California Workers' Compensation Appeals Board approved the settlement on March 5, specifically citing materials submitted by ophthalmologist Dr. William F. Hoyt, but Hoyt recently claimed in an interview that Robinson's claim is "fraudulent and has no merit whatsoever."

ETC...

Assorted Notes...*The Journal of Microwave Power* has a new look. Volume 20, Number 1, the first issue of 1985 and the first under the editorship of Dr. W.A. Geoffrey Voss, has an eight-and-a-half by eleven-inch format and features nine research papers and a section on patents and book reviews. Among the papers is a re-analysis by Dr. Allan Frey of Dr. Budd Appleton's data on cataract risks due to exposure to microwave radiation — first reported in the November 1984 issue of *Microwave News*. The *Journal* is available free with membership in the International Microwave Power Institute (IMPI). Dues are $75.00 a year. Contact: IMPI, Tower Suite 520, 301 Maple Ave. West, Vienna, VA 22180, (703) 281-1515....Lightning strikes may not be random. According to an article in *The Washington Post* (June 27), Drs. Raul Lopez and Ronald Holle at NOAA's Environmental Research Labs in Boulder, CO, have found that local topography plays a major role in determining where a lightning bolt will strike. One study area was found to be hit by lightning more than 25 times each summer (see also the July 13 *Science News*) ....Radio Marti, U.S. broadcasts to Cuba, went on the air on May 20, and all those fears of Cuban retaliation by jamming American radio stations have not materialized. But Radio Marti has brought about one major policy change: according to a dispatch by Reuters on June 18, Cuban radio has lifted its ban on Frank Sinatra, which has been in effect since the early 1960's. "Come Fly With Me" is once again on the Cuban airwaves.

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Electropollution Symposium

Howard University, Washington, DC
September 9, 1985

Active workers in the field of radiofrequency and microwave biology are invited to submit an abstract. Best five will receive awards for travel and accommodations. Deadline for applications is August 26.

Contact:

Professor Richard Millis
Howard University
(202) 636-6933.

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Human Tumor Cells Thrive in ELF Magnetic Fields

Human tumor cells proliferate more easily and are more immune to attack when exposed to power line fields, according to Dr. Jerry Phillips of the Cancer Therapy and Research Foundation in San Antonio, TX.

Because the field effects persist for months after exposure to extremely low frequency (ELF) radiation, Phillips argues that 60 Hz fields "are capable of producing significant permanent changes in cellular structure and function."

Phillips's results, presented in a series of recent papers, may be the first step in explaining the abnormally high cancer rates identified among people exposed to electromagnetic fields (EMFs). "Our studies are very much in concert with the epidemiological studies that have been published," Phillips told *Microwave News* in a telephone interview.

A recent review of epidemiological surveys by Dr. Tom Tenforde of the Lawrence Berkeley Lab in California indicates that 15 of 17 reports showed "some apparent correlation between cancer and EMFs" (see *MWN*, March/April 1986). New findings continue to support an association between ELF and cancer (see *MWN*, May/June 1986).

(continued on p.13)

Workers Claim Radar Accident at Maine Shipyard

As many as 23 workers may have been exposed to high levels of radar radiation at the Bath Iron Works (BIW) shipyard in Portland, Maine, on March 19. BIW officials contest the men's claim that a U.S. Navy ship's radar was accidentally turned on while they worked nearby.

Most of the men reported facial burns, red arms and suntans following the alleged incident, even though it rained that day. Among the other most common complaints were severe headaches, irritated eyes, nausea and exhaustion. At least one worker says he is still suffering severe ill effects and has not returned to work.

The radiation came from an AN/SPS-49 long-range air-search radar aboard the U.S.S. Taylor, a guided-missile frigate, according to officials of Local 6 of the Industrial Union of Marine and Shipbuilders of America, which represents the workers. The radar was built by the Raytheon Co. of Wayland, MA.

A BIW spokesman told *Microwave News* that the radar was "sector-blanked" — that is, it could not have exposed the men in the shipyard. But Jim Mackie, the chief steward of Local 6, disagreed: "All somebody had to do was hit one button and the sector-blanking would have been turned off," he said in an interview.

Mackie pointed out that, at the time the radar is believed to have been on, walkie-talkies stopped working in the yard and fire alarms went off in the drydock for no apparent reason.

(continued on p.14)

HIGHLIGHTS

EPA's Four Options for Public Exposures to RF/MW Radiation

The Environmental Protection Agency (EPA) has proposed options for protecting the public from radiofrequency and microwave (RF/MW) radiation exposures: maximum specific absorption rates (SARs) of 0.04, 0.08 and 0.4 W/Kg, which translate into power densities of 100, 200 and 1,000 uW/cm², respectively. A fourth option is to take no official regulatory action (see box).

Which option EPA will finally select depends on numerous scientific and policy issues; in its *Federal Register* notice, the agency asks for public comments on how these issues should be resolved. Many key questions are unclear: EPA indicates that frequency-dependent power densities would be set based on the SARs but does not specify where, between 10 kHz and 100 GHz, the levels would change — that is, what is the resonant frequency range.

When and if EPA adopts — and the President approves — public exposure limits, formally called "Federal Guidance," affected agencies will be responsible for implementing them.

EPA began work on the guidance in the late 1970s and, in 1982, asked for public comments on six questions related to standard-setting (see *MWN*, January/February 1983). In 1984, the agency was about to propose what is now called option 1 (100 uW/cm²), but backed off in the face of opposition from EPA's policy office (see *MWN*, June and July/August 1984 and September/October 1985).

Since 1984, EPA's Office of Radiation Programs has waged an uphill battle against its own policy office and the Office of Management and Budget to propose the guidance. Delays followed delays and now, instead of proposing a single set of limits, EPA is again seeking public comments on a wide range of issues. According to the current timetable, EPA will issue a final guidance in December 1987. But it is more likely that the agency will be forced to issue a new proposal — and yet again ask for public comments — when it finally chooses one of the options. If so, the final guidance will be delayed at least until 1989.

Following a series of copyediting snafus, the EPA proposal finally appeared in the *Federal Register* on July 30 (51 *FR* 27,318) — more than six weeks after its release on June 12. Comments are due by October 28. EPA is sponsoring a public hearing September 22-23 at the GSA auditorium (18th and F Sts., NW) in Washington, DC.

Key Issues To Be Settled

At the heart of the decision on which option to select are three key questions: What margin of safety should EPA use to protect the public? How should it deal with non-thermal effects? and How should it resolve the question of RF/MW-induced carcinogenesis?

EPA states that adverse effects "begin to occur" between 1 and 4 W/Kg and that the exposure limits will be derived by applying a suitable safety factor — between 10 and 1,000 — "to compensate for unknowns and uncertainties."

The public health significance of non-thermal effects, at SARs of less than 1 W/Kg, "is not well understood," according to EPA: "The overall implications for human health of low-level non-thermal effects [are] not clear... further research is required to determine... whether they constitute a hazard to human health."

EPA states that it "believes RF radiation should now be treated as a non-carcinogen." Nevertheless, citing "some preliminary and unconfirmed studies," principally the long-term exposure study at the University of Washington in Seattle, in which rats exposed to an SAR of 0.4 W/Kg had increased rates of tumors, the agency left the door open to changing its mind, noting that the issue of carcinogenesis "is not yet resolved and could affect EPA's assessment."

Among the factors which will influence EPA's choice of the appropriate margin of safety are: (1) undetected sensitivities to radiation; (2) validity of animal data for gauging risks to humans; (3) lack of long-term exposure studies; (4) reliability of extrapolating from animal data to humans; (5) natural environmental and genetic variations among humans; (6) variations in environmental exposure conditions; (7) ill-characterized non-thermal effects; (8) lack of sensory mechanisms for warning against overexposure; (9) adequacy of the human thermoregulatory system; and (10) absence of a clear threshold for adverse effects.

Dealing with Shocks and Burns

"It is impractical to specify numerical electromagnetic field intensity limits that prevent all possible shock and burn effects," according to EPA. Under the three specific options, EPA estimates the induced currents in a grounded individual at 3 MHz to be 45 mA, 247 mA and 553 mA for options 1, 2 and 3, respectively. EPA points out that only option 1 results in a threshold for RF burns of less than 100 mA, as proposed by the National Institute for Occupational Safety and Health.

EPA advises that, "as a minimum, low frequency fields

U.K.'s NRPB Proposes ELF, RF & MW Standards

The United Kingdom's National Radiological Protection Board (NRPB) has just published proposed standards for occupational and general public exposures to non-ionizing radiation below 300 GHz. For occupational exposures to radiofrequency (RF) and microwave (MW) radiation, NRPB recommends the same levels as those set by the American National Standards Institute (ANSI) in 1982; for occupational exposures at 50 Hz, it proposes 30 kV/m and 10 mT for the electric and magnetic fields, respectively. For all frequencies, general population exposure limits are no more than 40 percent of the occupational levels.

NRPB has invited comments on its proposal and plans to issue a final standard by early 1987. *Advice on the Protection of Workers and Members of the Public from the Possible Hazards of Electric and Magnetic Fields with Frequencies Below 300 GHz: A Consultative Document* (May 1986) is available from NRPB, Chilton, Didcot, Oxon OX11 0RQ, U.K.

Microwave News will publish a full report on the NRPB proposal in our next issue.

EPA's Four Options

Excerpts from EPA's Federal Register *notice.*

Option 1: Guidance Based on an SAR of 0.04 W/Kg. Controlling public exposure by limiting whole-body average specific absorption rates (SARs) to 0.04 watts per kilogram (W/Kg) for frequencies above 3 megahertz (MHz) and by limiting electric field intensity to 87 volts per meter (V/m) and magnetic field intensity to 0.23 amperes per meter (A/m) at frequencies below 3 MHz.

This option represents a "no effects" level by protecting against thermally-related health effects in humans, including most sensitive subgroups of the population. No measurable changes in core temperature would occur at this level nor would any thermoregulatory responses be initiated. This level is consistent with the usual practice of providing substantially more protective standards (here, by a factor of 10, when compared to, for example, the 1982 ANSI voluntary standard of 0.4 W/Kg) for the public than those recommended for occupational exposures. This level might be viewed as unnecessarily stringent in that the health protection provided may not be commensurate with its cost, particularly in view of the present uncertainties surrounding low-level and nonthermal effects.

Option 2: Guidance Based on an SAR of 0.08 W/Kg. Controlling public exposure by limiting whole-body average SARs to 0.08 W/Kg for frequencies above 3 MHz and by limiting electric field intensity to 275 V/m and magnetic field intensity to 0.73 A/m for frequencies below 3 MHz.

This option also effectively represents a "no effects" level by protecting against thermally related health effects in humans, including most sensitive subgroups of the population. No changes in core temperature should occur at this level nor should any thermoregulatory responses be initiated. Also consistent with the usual practice of generally providing more protective standards for the public than those recommended for occupational exposures, this level differs from Option 1 in that it is lower than, for example, the 1982 ANSI guide by a factor of 5 rather than a factor of 10, as given in Option 1. This option is similar to the Massachusetts standard, to the IRPA guideline in the resonant frequency range and to the exposure limits recently recommended by the NCRP. The agency is particularly interested in comment on this option, because 42 U.S.C. 2021(h) states that the administrator shall consult with the NCRP, among others, on radiation matters.

Option 3: Guidance Based on an SAR of 0.4 W/Kg. Controlling public exposure by limiting whole-body average SARs to 0.4 W/Kg for frequencies above 3 MHz and by limiting electric field intensity to 614 V/m and magnetic field intensity to 1.63 A/m for frequencies below 3 MHz.

This option should protect against thermal effects except in possibly more susceptible or sensitive people or possibly at high ambient temperatures and humidities. This level corresponds to the lower end of the range postulated to be associated with the onset of thermoregulatory responses in humans. Effects that occur below this level do not, for the most part, seem to be caused by generalized heating. The 1982 ANSI standard, set at this level, does not differentiate between occupational and public exposure but noted, "...these guides are offered as upper limits of exposure, particularly for the population at large." Various groups in the broadcasting industry have indicated to EPA their willingness to comply with a guideline at this level (letters placed in the central docket). The agency is particularly interested in comment on this option, because it is similar to the 1982 ANSI guide voluntarily adopted by much of the broadcast industry and is to be used by the FCC to determine the need for environmental impact analyses for new and renewal license applications.

Option 4: Conduct Other Activities in Lieu of Adopting Federal Radiation Protection Guidance for RF Radiation. In lieu of adopting Federal Guidance for RF radiation, establishing public awareness programs to distribute information on health effects and environmental measurements as well as provide technical assistance to states and federal agencies.

This is a nonregulatory option, and it would provide public health protection only as it is realized indirectly through the advice and technical assistance provided by EPA to federal agencies, states or industry. Taking no regulatory action at this time could permit any further regulatory action to be based on more refined biological, technical and economic analyses. For example, allowing more time for additional research to identify and quantify adverse health effects in the population may result in more improved risk estimates. It is not clear whether this approach will meet the perceived need of federal agencies, states or industry that have requested uniform federal exposure guideliness, and EPA seeks comments on this issue.

should be limited to intensities that prevent accident-causing startle reactions in ungrounded individuals who may momentarily contact grounded objects" in high RF fields.

In addition, the EPA proposal:

- Specifies no limits for peak intensities of pulsed fields;
- Suggests limits that are ten times less stringent for exposures of less than six minutes in any one hour, as long as the total energy absorbed is no greater than would be absorbed in one hour under continuous exposure;
- States that it is "impractical to distinguish between partial-body and whole-body exposures" and proposes that the limits apply to all exposures;
- Makes no special provisions for modulated fields because the scientific data "is not considered to be sufficiently developed";
- Excludes exposures from medical devices and consumer products.

EPA's economic analyses (see *MWN*, September/October 1985) show that even the most stringent controls (option 1) would have a relatively minor impact on federal RF/MW activities — EPA notes that even though some agencies differed with these estimates, one part of the Defense Department agreed.

Comments on the EPA options should be sent to: Central Docket Section (LE-131), U.S. EPA, Attention: Docket No.A-81-43, Washington, D.C. 20460.

The EPA Office of Radiation Programs recently moved. The new telephone numbers are: Dave Janes and Doreen Hill at (202) 475-9626; Norbert Hankin at (202) 475-9630. Their mailing address remains the same.

Wertheimer-Leeper ELF Exposure Estimates Confirmed

Reports from two ongoing epidemiological studies have confirmed the reliability of the coding scheme developed by Dr. Nancy Wertheimer and Ed Leeper to estimate human exposures to extremely low frequency (ELF) magnetic fields.

At the Bioelectromagnetics Society (BEMS) meeting in Madison, WI, in June, members of both study teams reported that detailed magnetic field measurements supported the Wertheimer-Leeper claim that residential exposures can be estimated by checking the wiring configuration near a given home. The two studies, funded by the New York State Power Line Project, are designed to test the Wertheimer-Leeper finding of a link between exposures to weak alternating magnetic fields and cancer (see *MWN*, September 1983).

Neither research group presented any results at BEMS on the key question of the possible relationship between ELF fields and cancer. These are expected to be ready for the Department of Energy and Electric Power Research Institute (EPRI) contractors review to be held in Denver, CO, in November.

Ground Currents

Bill Kaune of the Battelle Pacific Northwest Labs concluded that the "Wertheimer-Leeper method of wiring classification is correlated with residential magnetic fields" and that "our data are supportive of the idea, first suggested by Wertheimer and Leeper, that ground currents are a significant source of residential magnetic fields." Kaune pointed out that there is still considerable variability in magnetic fields within each category.

Drs. Frank Barnes and Howard Wachtel of the University of Colorado in Boulder reached a similar conclusion: on average, the magnetic fields are determined by sources outside the house, in a manner consistent with the Wertheimer-Leeper coding scheme. They too found that there can be substantial variation among different houses within a given class.

Asked whether he agreed with Kaune on the importance of ground currents, Wachtel told *Microwave News* that the greatest contributions to the magnetic fields come from outside the house and that they might be due to the ground currents. Household power does not affect the magnetic fields inside the home, he said.

In a telephone interview, Dr. David Savitz, an epidemiologist at the University of North Carolina in Chapel Hill who is in the process of analyzing the Colorado data, called the new findings "a clear confirmation of the Wertheimer-Leeper exposure methodology."

This classification scheme has been criticized in the past. For instance, in an evaluation for EPRI, Daniel Roth, a consultant, reported that, "It is difficult...to accept Wertheimer and Leeper's conjecture that wiring configuration was a surrogate measure for magnetic fields..." (see *MWN*, May 1985).

Nevertheless, the method has won a considerable following — perhaps too great. Wertheimer and Leeper are now worried that others are using their coding system without first checking as to whether there is a correlation between local wiring and household magnetic fields in specific study areas. They are particularly concerned about the use of their technique in Europe (see "From the Field" on p.9).

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VDT Pregnancy Studies Increase Uncertainty Over Possible Hazards

New and previously released epidemiological studies presented in May at a conference on video display terminals (VDTs) in Stockholm, Sweden, suggested that VDT work might adversely affect pregnant women, although most speakers dismissed the possibility of any risk.

Of the five major studies presented, four showed some positive associations. Two indicated increased rates of cardiovascular abnormalities in children born to women who used VDTs. A third suggested a tendency toward increased rates of spontaneous abortions among women who worked moderate amounts of time at VDTs — but not among those who worked long periods at VDTs. And the fourth found higher rates of abnormal pregnancies among VDT operators who were under stress.

Only one scientist reported an increased risk and advised against VDT work during pregnancy. Several researchers, while discounting their positive results as anomalous, called for further epidemiological studies.

Heart Defects In Sweden and Finland

A Swedish study of more than 4,000 births between 1980 and 1983 found 57 "significant malformations" among offspring of women with some or considerable VDT exposure, compared to 9 such malformations among babies of those with little or no exposure — yielding an odds ratio of 1.9, or a near doubling of the risk of defects. Lead researcher Peter Westerholm of the Swedish Trade Union Confederation admitted that this difference was of borderline statistical significance but concluded that there was no increased risk.

Among the 57 births involving serious defects, Westerholm and coworker Anders Ericson of Sweden's National Board of Health and Social Welfare found 12 cases of cardiovascular malformations, but they found no defects of this type in the control group.

The study team used computerized personnel records to identify job categories; employers and trade union officials subsequently estimated VDT use.

Westerholm reported that the group of women who spent moderate amounts of time doing VDT work had the highest rate — 3.4 percent — of significantly malformed babies, compared to 1.6 percent or less for those who did either more or less work. He called this finding "paradoxical," saying

that the highest rate should have occurred among the women with the greatest exposures.

Dr. Karel Marha of the Canadian Center for Occupational Health and Safety in Hamilton, Ontario, responded from the audience that neither Westerholm's study nor any of the others controlled for "unintended" exposures to terminals – the amount of time a woman is not operating a VDT but is nonetheless working near one. "I would like to see an epidemiological study where exposure is well-defined relative to the location of the VDT," he said.

A second study also showed an increase in cardiovascular abnormalities among children born to women who used VDTs. Here again, the increase occurred only among part-time VDT operators. A group led by Dr. Kari Kurppa of the Institute of Occupational Health in Helsinki, Finland, reported 13 such birth defects among children of exposed women, compared to 8 among offspring of unexposed women (odds ratio of 1.6). Of the 13, 8 were among part-time workers (less than 4 hours/day), compared to only 3 among controls.

Kurppa's team had previously reported the results of this case-referent study in *The Lancet* (December 8, 1984) and in the *Scandinavian Journal of Work, Environment and Health, 11,* pp.353-356, 1985 (see *MWN,* January/February 1985 and March/April 1986, respectively).

The seemingly inconsistent finding of increased pregnancy risks among operators who worked part-time at VDTs showed up yet again in the presentation by Canadian researcher Dr. Alison McDonald. Reporting on data first released in 1984, she pointed out an increased rate of abnormal pregnancies among moderate VDT operators but not among more regular users.

McDonald discounted her positive results, not only because the dose-response relationship was unusual but also because the rate of spontaneous abortions among non-VDT workers was lower than expected. She attributed the positive findings to recall bias and concluded that there is "no convincing evidence that use of VDTs during pregnancy increases birth defects or spontaneous abortions."

Dr. Henryk Mikolajczyk of the Institute of Occupational Medicine in Lodz, Poland, was the only speaker who concluded that VDTs pose a risk to pregnant women. His survey of 185 women, who worked for the Polish Airlines (135 women) or for a building construction bureau (50 women), indicated that work at VDTs under high-stress conditions may harm fetal development.

At the airline office, where the women experienced high levels of stress, the 89 VDT operators suffered 22 spontaneous abortions, compared to 8 among the 46 controls. At the other, low-stress office, however, none of the VDT users miscarried, while 5 of the controls reported spontaneous abortions.

VDTs, Stress and Smoking Linked to Problem Pregnancies

A new, two-part study indicates that VDT exposure, stress and smoking are all related to abnormal pregnancy outcomes, leaving open the possibility of a link between VDTs and birth defects and/or spontaneous abortions.

Swedish researchers Anders Ericson of the National Board of Health and Social Welfare and Dr. Bengt Kallen of the University of Lund concluded that, "The question of a possible reproductive hazard associated with video screen work is by no means finally settled." They believe that the possible risk of birth defects is greater than that of spontaneous abortions, though they doubt that VDT work increases either significantly.

After examining national birth registry and medical records of approximately 10,000 pregnancies, Ericson and Kallen reported indications of an increased risk of problem pregnancies among women with the greatest VDT exposure. Interestingly, of the three job categories classified as "high" exposure groups – computer personnel, travel agency clerks and insurance clerks – computer personnel suffered a markedly higher rate of significant infant malformations than did the other two groups, accounting for the increase of the whole "high" exposure group relative to the "low" and "medium" groups.

Ericson and Kallen also compared pregnancy outcomes from 1976-1977 to those from 1980-1981 and observed "faint indications" of increased spontaneous abortion and malformation rates in the latter period, when VDTs were more widely used. The number of spontaneous abortions in 1976-1977 was lower than expected, the authors warned.

Investigating further, Ericson and Kallen ran a case-control study of 522 cases of significant birth defects and spontaneous abortions compared to 1,032 controls. As in part one, they analyzed the data according to low, medium and high VDT exposures.

They found a statistically significant, dose-dependent association between VDT work and birth defects but cautioned that they were unable to separate VDT work from other variables. "If a relation between birth defects and video screen work is actually present," they wrote, "it is most likely an effect of stress at work, perhaps combined with smoking."

The researchers noted that they included only spontaneous abortion cases for which women were hospitalized and thus may have excluded early miscarriages; they also cautioned that the data collected by questionnaires in the second part of the study may have suffered from recall bias.

The study papers, "An Epidemiological Study of Work with Video Screens and Pregnancy Outcome: I. A Registry Study" and "II. A Case-Control Study," appeared in the *American Journal of Industrial Medicine, 9,* pp.447-457 and pp.459-475, respectively, 1986. They were originally published last year in Swedish.

Relaxation of ANSI RF/MW Safety Standard Proposed; Literature Review Incomplete

The first draft revision of the 1982 American National Standards Institute (ANSI) safety standard for human exposures to radiofrequency and microwave (RF/MW) radiation includes a number of proposals to relax the limits.

At a two-day meeting in Madison, WI, June 6-7, Dr. Kristian Storm, chairman of subcommittee C95.IV, which is rewriting the standard, outlined some of the proposed changes. These include:

- Doubling the allowed exposure levels above 3 GHz from 5 mW/cm^2 to 10 mW/cm^2 and extending that limit from the present 100 GHz to 300 GHz.
- Adding protection against shock and burns, while loosening the allowable exposures to magnetic fields at low frequencies and extending the standard's applicability down to 3 kHz.
- Increasing the limits for partial-body exposures from the present 8 W/Kg possibly up to 24 W/Kg.
- Exempting medical diagnostic devices.

The specificity of the proposed changes caught many members of the subcommittee by surprise because the review and analysis of research papers — the basis for the new standard — are incomplete. Of the 310 recent papers that the subcommittee has identified as possibly germane to the revision, only 43 have so far been evaluated.

Speaker after speaker said it was too early to talk about biological thresholds for radiation effects because the various working groups have not completed the evaluations. Dr. Joe Lary of the National Institute for Occupational Safety and Health asked, "How are we going to get a consensus if the literature review isn't done?"

"We must proceed, time is of the essence," Storm replied. Under ANSI rules, all standards must be reaffirmed or revised every five years; action is therefore due by 1987.

In a series of interviews with *Microwave News,* most subcommittee members said that they agreed with Lary. Jules Cohen, a consultant to the broadcasting industry, said "It is too early to vote on biologically-based limits." And Dr. John Monahan of the Food and Drug Administration (FDA) commented, "It's all backwards." Storm was supported by the subcommittee's secretary, Dr. John Osepchuk of Raytheon, who said that there was no need to wait for the literature review because we "more or less know where things should go."

The subcommittee approved the extension of the standard's frequency limits down to 3 kHz and up to 300 GHz but did not vote on any exposure limits.

A Two-Tier Standard

There was extended debate on whether the standard should be changed to recommend different limits for workers and for the general public, prompted in large part by a letter from FDA's Dr. Mays Swicord, who was unable to attend the meeting. Swicord wrote, in part: "Without convincing and well-substantiated arguments to the contrary, different exposure limits should be adopted" for each group. He noted that the International Radiation Protection Association (IRPA) and the National Council on Radiation Protection and Measurements (NCRP) have adopted two-tier standards, in contrast to the 1982 ANSI standard.

Dr. Carl Sutton, a medical doctor, favored a two-tier standard as "the only way to go," while Ralph Justus of the National Association of Broadcasters argued against it. Dr. Bud Appleton, a consultant, said that there was no need for two standards because there are no chronic effects from exposure. Others, like Dr. John Bergeron of General Electric and Dr. Elliot Postow of the Naval Medical R&D Command, suggested that the subcommittee should only recommend an occupational standard. But Dr. Quirino Balzano of Motorola warned that if ANSI fails to set a population standard, everybody will use the recently released NCRP standard that specifies fivefold stricter limits for the public than for workers (see *MWN,* May/June 1986).

The problem of how to handle the threat of shock and burns at low frequencies swayed many in favor of a dual standard. While workers could be trained to minimize these risks, most of the subcommittee agreed that this would be an impractical solution for the public.

The final compromise was to adopt the concept of different standards for workers and for the public, while leaving the door open to the possibility that the subcommittee may recommend the same limits for both groups in specific frequency bands. When the question was called for a vote, some subcommittee members, such as Dr. Eleanor Adair of the John Pierce Foundation, asked whether it was appropriate to vote when the literature data base was incomplete. Storm insisted it was appropriate, saying, "We have a mandate and time is short."

Two Options for Shocks and Burns

The most detailed discussion of new research focused on the threat of shocks and burns at low frequencies. Awareness of these risks stems from research by Drs. Om Gandhi of the University of Utah in Salt Lake City and Bill Guy of the University of Washington in Seattle (see *MWN,* July/August 1985 and the "Biological Effects" Update on p.10). Each offered a different way of minimizing these hazards, however, arguing that the other's proposal was too strict.

Gandhi suggested tightening the time-averaged power density limits by a factor of ten in the 300 kHz to 300 MHz band; Guy called this "ridiculous" because the problem only exists for high power sources. On the other hand, Guy favored a maximum body current of 50 milliamps (mA) and training workers to protect themselves. Gandhi questioned how such a limit could be enforced and said that this approach was "overly restrictive" because a 50 mA limit represented a tightening of the electric field standard limit by a factor of 16 and of the power density by a factor of 256.

Richard Tell of the Environmental Protection Agency noted that, below 300 MHz, the new electric field standard for the general population may have to be tightened by more

than the factor of ten proposed by Gandhi. And Storm observed that "There is a clear need to do something at low frequencies." But no consensus emerged.

Proposal for 10 mW/cm² Standard Above 3 GHz

Guy and Gandhi also disagreed on the preferred limits at higher frequencies. Gandhi said that he was against doubling the exposure limit to 10 mW/cm² above 3 GHz, while Guy said that he was not taking any side. Raytheon's Osepchuk said that the proposal was based on the desire to match the infrared (IR) standard of 10 mW/cm² above 300 GHz.

Guy argued that temperature distribution at 3 GHz is very similar to that associated with IR radiation. Gandhi countered that IR and millimeter waves are very different because millimeter waves can penetrate clothing while IR cannot and that the two types of radiation will therefore cause very different thermal loads.

Some of those present, like Gandhi, questioned the origin of the IR 10 mW/cm² standard. Only the ANSI laser standard of 10 mW/cm² was mentioned as the possible source of the IR limit.

NIOSH's Lary said that he did not think that 10 mW/cm² would be sufficiently protective below 30 GHz. Motorola's Balzano agreed.

No one raised the question of how to handle the results of the long-term, chronic-exposure study from Guy's lab suggesting that microwaves can promote cancer (see *MWN*, July/August 1984 and March 1985).

Are Committee Members Liable?

At a meeting of the full C95 committee on June 4, the panel discussed at length whether members of standard-setting committees are liable for their actions — an issue which gained widespread significance in 1982 when the U.S. Supreme Court ruled that the American Society of Mechanical Engineers was liable for a multi-million dollar award as a result of the unethical conduct of one of its committee members in developing a boiler standard (see *MWN*, June 1982).

Both Bertram Stanleigh of the IEEE and Steve Caine of the Navy, the two sponsors of the C95 committee, said that only their designated representatives were protected. Raytheon's Osepchuk argued that the IEEE should indemnify all the committee members. Stanleigh said that he would advise the IEEE management of the request but doubted there would be a change of policy.

Some members of the subcommittee rewriting the RF/MW safety standard abstained from voting out of concern over possible later liability.

Australian Power Line Dispute

A controversy over the siting of a power line is raging in the state of Victoria, Australia. At issue is an 8 km, 220 kV, 50 Hz line that would run between Richmond and Brunswick at a cost of $12 million (Australian).

In an effort to quell public opposition, the state government of Victoria brought in Dr. H.B. Graves, formerly of Pennsylvania State University in University Park and now a private consultant based in Corpus Christi, TX, to review the health risks associated with power line radiation. In a report submitted in March, Graves concluded that adverse public health effects "have not been established."

Area residents were not appeased. Led by Ian Macmillan of both the Collingwood Community Health Center (CCHC) and the Collingwood Residents Association (CRA), they charged that Graves's report is biased: "From the evidence available to us, it appears that Dr. Graves *is* aligned to one side of a now highly polarized debate, and should not hold such an influential position in this case."

The proposed line would replace an existing 66 kV line and would generally follow the present route through several communities in the Yarra River and Merri Creek valleys. In a 1 km stretch through a populated area, it would be placed underground. Also, the line would cross public school grounds. Last fall, concerned parents stepped up their opposition to the project when they learned of the $25 million award against Houston Lighting and Power Co. (HL&P) for siting a power line on school property (see *MWN*, November/December 1985).

In June, CCHC and CRA flew in Dr. Jerry Phillips of the Cancer Therapy and Research Foundation in San Antonio, TX, to rebut Graves's testimony. Phillips had testified at the HL&P trial.

The final decision on whether to build, delay or abandon the line lies with Robert Fordham, the Victoria Minister for Industry, Technology and Resources. He is expected to make an announcement in August.

Graves's report, *A Review of the State Electricity Commission of Victoria (SECV) Transmission Line and Station Design Practices in Relationship to the Health and Safety Effects on People*, was submitted to David White, the Victoria Minister for Health.

DoD's TEMPEST Program Badly Run, GAO Reports

Poor management of the Department of Defense's (DoD) TEMPEST program has resulted in millions of dollars of unnecessary expenditures and may have led to the disclosure of classified information, according to the General Accounting Office (GAO), a congressional investigative office.

The TEMPEST program, intended to protect classified electronic information, uses special shielding to prevent the unauthorized reception of stray radiation signals. The annual cost of TEMPEST is unknown, but GAO estimates that it is hundreds of millions of dollars.

In its new report, GAO found that DoD "often" failed to evaluate the need for TEMPEST measures, leading the department, in some instances, to "spend more money than necessary to protect classified information." Conversely, the lack of evaluations "could also result in insufficient protection being given to classified information."

A GAO spokesperson told *Microwave News* that it found no evidence of actual leaks.

GAO also charged that the Air Force, the Army and the Navy have been "slow" to implement security procedures issued in 1984 (see *MWN*, September 1984): As of June

1986, none of the three services had fully implemented the January 1984 National Communications Security Instruction (NACSI) 5004, which sets out TEMPEST procedures. In addition, GAO said that the services had administered the procedures separately and inconsistently and that all three had "usually" failed to inspect contractors' equipment to ensure TEMPEST compliance.

Enforcement Inadequate

Enforcement of TEMPEST requirements in DoD contracts is inadequate, GAO concluded. DoD's Defense Investigative Service (DIS), which is authorized to inspect contractors' facilities, cannot disapprove a system for TEMPEST violations. Instead, DIS must notify DoD contracting officers, some of whom do not know that they are responsible for enforcement and consequently fail to act when notified.

GAO recommended that the Secretary of Defense implement a new TEMPEST-related security policy and consider consolidating enforcement in a single office.

The report, *DoD TEMPEST Protection: Better Evaluations Needed to Determine Required Countermeasures,* was prepared for Congressman Glenn English (D-OK), chairman of the subcommittee on government information, justice and agriculture of the House Committee on Government Operations. A subcommittee spokesperson said that Congressman English is not planning hearings or any other follow-up work.

NSA Objection

The National Security Agency (NSA), which manages TEMPEST-related activities for DoD, objected to the release of the study but did not place a security classification on it. According to GAO, NSA "believes that, although not technically classified, this report contains 'extremely sensitive information, which, if made public, would be detrimental to the United States Government TEMPEST program.'" The subcommittee spokesperson told *Microwave News* that Congressman English had requested an unclassified report.

Vernon Microwave Radiation Levels in Picowatt Range

The residents of Vernon Township, New Jersey, are exposed to "significantly lower levels" of electromagnetic fields than most Americans, according to the Environmental Protection Agency (EPA). In measurements taken last November, EPA found that the average radiation levels were approximately 226 picowatts per centimeter squared (pW/cm^2), or 226 x 10^{-6} uW/cm^2, and, at some sites, the levels were below the detection limits of the measurement equipment. The maximum reading in the town was 2,810 pW/cm^2.

Vernon has been the center of a continuing controversy after a cluster of Down's Syndrome cases was identified among babies born to local residents (see *MWN,* May 1985). Citizens Against the Tower (CAT), a Vernon citizen's group, blames the cluster on exposures to microwaves because of the high concentration of radiation sources in the town: there are three satellite stations in Vernon with more than 15 uplink antennas and numerous point-to-point transmitters.

The highest radiation level measured by EPA was 60 uW/cm^2 in the 6 GHz band on a hillside on RCA property near its satellite station. EPA found that the power density fell to less than 10 uW/cm^2 beyond 650 feet from the antenna. New Jersey has a 5,000 uW/cm^2 standard at this frequency.

According to EPA, the measurements have an uncertainty of up to 3 dB — that is, they could be either too high or too low by a factor of 2.

CAT criticized the report for failing to provide a complete survey of the radiation pattern in the town. "They did not do what was necessary," CAT's Elise Kreindler said in an interview. "The report does not in any way begin to answer the question of disease pattern and its possible linkage to microwaves."

In its report, EPA admits to having done less than CAT had originally asked: "Inclement weather (rain, sleet, snow, icy roads) and time constraints limited the number of community measurement sites to 25."

In an "Analysis" of the EPA report, Dr. Robert Becker and Adam Becker called the results "completely inadequate" and the report itself "significantly flawed." They were especially critical of the limited number of measurements: "It is rather like taking thimblefuls of dirt from 25 randomly selected areas at Love Canal to assess the chemical contamination in the entire area." Robert Becker is the author of *The Body Electric: Electromagnetism and the Foundation of Life.*

Sidelobes Missed?

One of the unexpected findings in the EPA report is a power density of 2,810 pW/cm^2 in the 11 GHz band measured at the Rolling Hills Primary School, located near the American Satellite facility. This reading, EPA believes, was due to a terrestrial point-to-point relay.

The Beckers attributed the reading to a side lobe from a low power relay, which indicated to them that there must

Our Electrical Environment

Fifty to 100 lightning bolts hit the earth every second, killing hundreds of people each year, causing forest fires, threatening aircraft and damaging sensitive electronic equipment. They are the leading cause of power failures, such as the one that blacked out New York City in 1977.

Lightning is the most obvious manifestation of our complex electrical environment, which extends from the million amp currents that flow in the upper atmosphere down to the telluric currents in the oceans.

What we know about all this — and what we don't — is the subject of a new, major report by the National Academy of Science-National Research Council's Geophysics Study Committee. *The Earth's Electrical Environment,* a 263-page, well-illustrated volume, consists of 16 chapters, written by leading researchers in the field. It is available for $26.95 from the National Academy Press, 2101 Constitution Ave., NW, Washington, DC 20418.

be side lobes from the higher power earth stations, which EPA failed to identify due to its limited survey of the town.

Dr. Jeremy Raines, a consultant based in Potomac, MD, also voiced concern over the possibility that, in light of the 2,810 pW/cm² reading, EPA may have missed sites with higher power densities. In a letter to CAT, Raines contrasted what he called "very strong" signals from the satellite dishes with the contention, voiced at Vernon town hearings, that they were imperceptible or unmeasurable.

Advisory Committee

The radiation measurements were prompted, in part, by a November 1985 recommendation from the Centers for Disease Control (CDC) in a report confirming the existence of a Down's Syndrome cluster (see *MWN*, November/December 1985). CDC also advised the state's Department of Health to set up a scientific advisory panel with representatives selected by the state and by CAT.

The panel is expected to hold its first meeting in August. CAT has selected Dr. Ruey Lin of the Maryland Department of Health and Mental Hygiene to be its nominee to the panel. The New Jersey Bureau of Radiation Protection will be represented by Ron Peterson of AT&T Bell Labs.

As the microwave debate continues, Vernon has been faced with another radiation controversy. The state Department of Environmental Protection has selected the town for the burial of 5,000 drums of radon-contaminated soil. Vernon Mayor Victor Marotta was quoted by UPI as telling 5,000 protesters that local officials "will do what they have to do" to block the shipment. The town is in the process of appealing the decision in the state courts.

A copy of the EPA report, *An Investigation of Microwave and Radiofrequency Radiation Levels in Vernon Township, New Jersey, November 10-16, 1985,* June 1986, is available from Debby Wenke, Bureau of Radiation Protection, 380 Scotch Road, Trenton, NJ 08628, (609) 530-4003.

FROM THE FIELD

Wertheimer and Leeper: Estimating ELF Exposures

Reprinted below is a May 29th memo by Ed Leeper and Dr. Nancy Wertheimer on the Necessity for Taking Representative Magnetic Field Measurements in the Study Locale Before Using Wiring Configuration as an Indicator of Field Exposure for an Epidemiological Study.

This memo was prompted by the use of the Leeper-Wertheimer coding scheme by researchers in Europe. For a copy of Leeper's memo on Details of Wiring System Features with Particular Reference to U.S./European Differences, *send a self-addressed, stamped envelope to Leeper, Salina Star Route, Boulder, CO 80302.* *See also story on p.4.*

Since we published, in 1979, our first work linking cancer incidence with "wiring configuration," we have been pleased to see several other research groups using similar methods to study the epidemiology of ELF magnetic fields. We feel that wiring configuration is a fruitful way to assess long-term ELF magnetic field exposure in the home environment. Perhaps it is even the "best" or "only" way, especially when what is needed is to assess exposure at some past time.

However, we have been disturbed to see instances where the wiring configuration technique has been used without sufficient attention to the difficulties that may be expected.

The central problem is that *production of significant ELF magnetic fields by the electrical distribution system or home wiring is extremely dependent on details of that distribution system or home wiring.* Within one geographical area there can be enough standardization of wiring practices (because of building codes and the presence of only a single electric utility) to allow a statistically valid link to be discovered between easily determined physical features of the distribution of home wiring systems and the expected level of long-term ELF magnetic field exposure in the home. But wiring practices in another geographical area may be sufficiently different to require establishing that link all over again in a new way.

As we travel, even within this country, we are struck by how differently electrical distribution is implemented by power companies in different areas. But in *other* countries, the differences that we understand to exist are enormous — particularly in the all-important area of grounding practices.

In addition, several examples have come to our attention of home wiring practices used in other countries that are different from those used here and that would or could cause fields from home wiring to dominate the field exposure in the home.

Within the U.S., uniform wiring codes would seem to assure that other workers will find what we did: that wiring within the home rarely contributes substantially to the general magnetic field exposure within that home. But that hypothesis should not be assumed to be true in another country, without testing.

In any case, wherever work is done, *it is essential to take representative magnetic field measurements to establish a link between physical features ("configuration") and expected magnetic field exposure that will be valid for the locale in which the epidemiological research is to be done.* That point cannot be overemphasized.

Our own work has from the beginning included a program of measurements to identify physical features typically associated with elevated magnetic fields. For a variety of reasons, we find that this cannot be done by theory alone.

It was perhaps a mistake on our part that in our early publications on wiring configuration we did not (for reasons of space) emphasize the measurement-based empirical procedure we used to determine the particular wiring configurations we chose to compare with cancer rates. That was partly because at that time we took the conservative position that we had determined an apparent link only between certain wiring configurations and cancer. We were perhaps being overly cautious in doing that, since in fact those configurations were selected for their typical production of high magnetic fields.

In any case, seven years later and thanks to a variety of related work, the hypothesis to be tested is now rather clearly one of whether magnetic field exposure per se is linked to cancer. And that can be done using wiring configuration or the presence of other physical features only if representative measurements are taken in the locale of the study to determine what physical features are associated, *in that locale,* with elevated magnetic fields. Big wires don't always make big fields, and relatively small wires can make surprisingly strong fields in certain situations. In addition, especially outside the U.S., fields from wiring source[s] within the home may "swamp out" fields from outdoor distribution system wiring.

UPDATES

BIOLOGICAL EFFECTS

Calming with Microwaves... Pulsed microwaves at power densities as low as 50 uW/cm² can decrease aggressive behavior in rats, according to Drs. Allan Frey and Jack Spector of Randomline, Inc., in Huntingdon Valley, PA. In a paper scheduled to appear in the June issue of *Aggressive Behavior* (Vol.12, No.4), Frey and Spector report that rats exposed to 1.3 GHz radiation with a pulse width of 0.5 msec, a repetition rate of 1,000 pps and average incident power densities of 50 and 100 uW/cm² were significantly less likely to assault other rats, as measured by a well-defined method for quantifying aggressive behavior. Exposures at 20 uW/cm² did not affect the rats. Frey and Spector also found that the "pulse width did not appear to be critical." The results are consistent with Frey's hypothesis that low intensity electromagnetic energy can influence the dopamine-opiate systems in the brain (see *Journal of Bioelectricity, 3,* pp.373-383, 1984).

Induced Currents at 3-60 MHz... In our July/August 1985 issue, we reported on the latest research by Professor Om Gandhi and coworkers at the University of Utah in Salt Lake City showing that exposure to radiation in the 3-60 MHz band, at levels allowed under the 1982 ANSI safety standard, can result in high SARs and large currents flowing through the ankles and feet of barefoot individuals. These results have now been published in the August 1986 issue of the *IEEE Transactions on Biomedical Engineering.* Gandhi writes that, "The highest foot current for a 1.75 m human adult is observed at about 40 MHz with a value on the order of 12.7 mA/(V/m)." At 40 MHz, the ANSI standard is 61.4 V/m (1 mW/cm²), which would result in a 780 mA foot current and an SAR of 243 W/Kg in the ankles. For five- and ten-year-olds, the maximum ankle SARs are 534 W/Kg at 62.5 MHz and 371 W/Kg at 50.7 MHz, respectively. (ANSI specifies a maximum partial-body SAR of 8 W/Kg. See the report on the ANSI subcommittee's deliberations on this new data on p.6.) Gandhi's team also studied the currents induced from working at RF sealers. Douglas Hill and Alan Walsh of the Defense Research Establishment in Ottawa have estimated lower SARs through the ankles (see "Radiofrequency Current Through the Feet of a Grounded Human" in the February 1985 *IEEE Transactions on Electromagnetic Compatibility.)* Gandhi ascribes the Canadians' low values to their overly simplified model of the human ankle.

COMPATIBILITY & INTERFERENCE

Ovens and DBS... Direct broadcast satellites (DBS) promise to change the way people tune in television signals, especially in Europe and Japan, but their reception may be hurt by another household appliance, the microwave oven. Most ovens now operate at 2.45 GHz, and emissions of their fifth harmonic could therefore interfere with downlink satellite transmissions in the 12 GHz band. A team from Hitachi's Mobara Works in Japan has been studying ways of suppressing emissions from an oven's magnetron by fitting a choke to its output antenna. In a paper presented at the *21st Annual Microwave Power Symposium* in Memphis, TN, at the end of July, Akikazu Harada and coworkers indicated that they have succeeded in reducing the fifth harmonic by 20 dB and predicted that their suppression methods will soon be incorporated in the mass production of magnetrons for ovens; this and more may be necessary if new, stringent limits are adopted for ISM equipment. They pointed out one tradeoff, however: reducing the fifth harmonic can result in higher emissions of other harmonics. An abstract of their paper appears in the *Journal of Microwave Power, 21,* p.90, 1986.

ARRL Petition Denied... The FCC has turned down the American Radio Relay League's (ARRL) April 22 request for mandatory EMI susceptibility labeling of home electronics equipment (see *MWN,* March/April 1986). In rejecting the ARRL's petition, FCC Chief Engineer Thomas Stanley reasoned that determining which of two labels to apply — one for equipment with EMI controls and one for equipment without — would require the FCC to develop and implement EMI susceptibility standards. The FCC has decided instead to maintain its position of "minimum regulatory involvement," relying on manufacturers to comply with voluntary guidelines. The ARRL has already filed a petition for reconsideration.

The Long Electronic Arm of the Law... Captain Midnight, the video vandal who overrode a Home Box Office (HBO) movie in April to protest the network's decision to scramble its signals, has been caught. The FCC got its man — John MacDougall, a 25-year-old Floridian who owns a satellite dish sales company — with the help of some electronic sleuthing. Because only a handful of the 2,000 U.S. satellite uplink stations are large enough and powerful enough to override the HBO signal, and because only a few have the right type of character generator, federal sleuths narrowed their search to less than a dozen sites. Then, with the help of a hot tip from an overheard telephone call, they narrowed in on the Central Florida Teleport at Ocala. MacDougall surrendered on July 22 and plea-bargained a sentence of one-year unsupervised probation and a $5,000 fine. HBO Chairman Michael Fuchs, obviously satisfied with the FCC's feat, warned that his company has taken "certain precautions" to discourage future video intruders. Nevertheless, satellite experts have a whole new set of worries: What, they ask, if a terrorist could order a satellite to leave its orbit and get lost in space?

Supersecret EMI... In Key West, FL, several would-be broadcasters trying to start a TV station on channel 3 have met stiff opposition from the Navy, according to the July 18 *Wall Street Journal.* The Navy apparently operates a communications center on the island, but it is so secret that the Navy refuses to even discuss the facility, except to say that the TV signals would interfere with it. Some people speculate that the base is a listening post for signals from Cuba. After meeting with the Navy, the FCC suggested that the station move to channel 8. To enable such a change, however, an educational station 60 miles away in Marathon, FL, would have to switch from channel 9 to channel 3.

New on the Market... KeyTek Instrument Corp. has developed two new surge generators (Models 587 and 587-Plus) for simulating AC power line transients to comply with ANSI C62.41-1980. The units, which cost $19,870 and $22,935, respectively, are described in the company's Bulletin

587/1, available free from Mike Hopkins, KeyTek Instrument Corp., 12 Cambridge St., Burlington, MA 01803, (617) 272-5170...The Southwest Research Institute (SwRI) in San Antonio, TX, has built a 16x16x28-foot anechoic chamber for EMI testing at frequencies as low as 30 MHz. For more information, contact William McGinnis, manager, SwRI EMC Services, 6220 Culebra Rd., PO Drawer 28510, San Antonio, TX 78284, (512) 684-5111...Amplifier Research has a new high-power horn antenna designed to reduce the problem of field strength loss at high frequencies. Model AT4001, which can operate in the frequency range 400-1,000 MHz, with an input power of up to 1,000 watts, is designed for shielded-room and open area RFI susceptibility and emission testing. The unit costs $2,000 and is available from Amplifier Research, 160 School House Rd., Souderton, PA 18964, (215) 723-8181...Electro-Metrics has improved its TEMPEST Test Receiver. The new NTR-51C is faster, lighter and smaller than the old NTR-51, while meeting or exceeding the requirements of NACSIM 5100A. Contact: Electro-Metrics Marketing Dept., 100 Church St., Amsterdam, NY 12010, (518) 843-2600...And, Systematics General of Vienna, VA, has adapted an Apple Macintosh computer to comply with TEMPEST standards. According to the announcement in the July 28 *InfoWorld,* the TEMPEST shielding increases the weight of the Macintosh from 17 to 26 pounds.

MEASUREMENT

New from NBS...Here are some of the latest reports and papers from the National Bureau of Standards...From their Technical Note series: • *A Radiofrequency Power Delivery System: Procedures for Error Analysis and Self-Calibration,* by Motohisa Kanda and R. David Orr (TN 1083). Order No. 003-003-02610-1, $1.00, prepaid, from U.S. Government Printing Office (GPO), Washington, DC 20402. • *Site Attenuation,* by R.G. FitzGerrell (TN 1089). Order No. 003-003-02708-1, $2.00, prepaid, from GPO. • *Interelement Interactions in Phased Arrays: Theory, Methods of Data Analysis, and Theoretical Simulations,* by Lorant Muth (TN 1091). Order No. 003-003-02715-4, $2.00, prepaid, from GPO. • *Direct Measurement of the Electric Field of a Laser Pulse — Theory,* by Eric Johnson, Jr. (TN 1084). Order No. 003-003-02697-2, $2.25, prepaid, from GPO...Recent bibliographies and compilations: • *Metrology for Electromagnetic Technology: A Bibliography of NBS Publications,* edited by Kathryn Kline and Mary DeWeese (NBSIR 85-3029). Order No. PB 86-130234, $11.95, prepaid, from National Technical Information Service (NTIS), Springfield, VA 22161. • *A Bibliography of the NBS Electromagnetic Fields Division Publications,* edited by Kathryn Gibson, Jessie Page and Charles Miller (NBSIR 85-3040). Order No. PB 86-191947, $11.95, prepaid, from NTIS. • *Precision Measurement and Calibration: Electricity,* edited by A.O. McCoubrey (SP 705). Order No. 003-003-02699-9, $23.00, prepaid, from GPO....New near-field publications: • *Development of Near-Field Test Procedures for Communication Satellite Antennas, Phase I, Part 1,* by Allen Newell and Andrew Repjar (NBSIR 85-3031). Order No. PB 86-1643577, $11.95, prepaid, from NTIS. • *An Efficient and Accurate Method for Calculating and Representing Power Density in the Near-Zone of Microwave Antennas,* by Richard Lewis and Allen Newell (NBSIR 85-3036). Order No. PB 86-181963/AS, $9.95, prepaid, from NTIS....Also of interest: • *Out-of-Band Response of Reflector Antennas,* by David Hill (NBSIR 85-3021). Order No. PB 85-224475/AS, $11.50, prepaid, from NTIS. • "Simple Approximate Expressions for Higher Order Mode Cutoff and Resonant Frequencies in TEM Cells," by Perry Wilson and Mark Ma in *IEEE Transactions on Electromagnetic Compatibility, 28,* pp.125-130, 1986.

MEDICAL APPLICATIONS

Pacemaker EMI...RF interference from a magnetic resonance imaging (MRI) scanner operating at 0.5 tesla caused total inhibition of atrial and ventricular output in three DDD pacemakers and dangerous atrial pacing in a fourth unit, according to Dr. Jay Erlebacher and his coworkers at the New York Hospital-Cornell Medical Center in New York City. In their paper, which appears in *The American Journal of Cardiology, 57,* pp.437-440, 1986, they conclude that "MRI scanning should be avoided in patients with implanted DDD pacemakers."

MEETINGS

BRAGS in Holland...The program for the *6th Annual Meeting of the Bioelectrical Repair and Growth Society (BRAGS)* has been finalized and it promises an international cast. Researchers from Belgium, Bulgaria, England, Israel, Italy, Poland, the Soviet Union, Sweden, West Germany, Yugoslavia, as well as from the U.S. and Canada, are scheduled to present papers in Utrecht, Holland, October 19-22. Special rates at the official conference hotel (Holiday Inn) will be available until September 1. And KLM is offering special airfares: in the U.S., contact Gerda Cooper at Rosenbluth's Travel, (800) 233-3158; elsewhere, contact KLM directly and mention BRAGS.

IRPA-7 in 1988...Non-ionizing radiation, usually the poor relation to ionizing radiation, is slowly gaining respect. At the *7th International Congress of the International Radiation Protection Association (IRPA)* to be held in Sydney, Australia, April 10-17, 1988, many of the sessions will address both types of radiation — the first time in IRPA history that they will be considered together. The week before the congress (April 5-8), there will be a workshop on *Non-Ionizing Radiation Biological Effects, Protection and Standards* in Melbourne. This review session will cover all types of non-ionizing radiation from ELF to microwaves to UV to IR and visible light, as well as lasers. The overall theme of the congress will be "Radiation Protection Practice." Papers are now being invited for oral and poster presentations, with abstracts due by March 15, 1987. For more information on both IRPA-7 and the workshop, contact J.C.E. Button, Health and Safety Division, Australian Atomic Energy Commission, Private Mail Bag, Sutherland, NSW 2232, Australia.

Complying with RF Broadcasting Rules...The National Association of Broadcasters (NAB) is sponsoring a one-day seminar on how to comply with RF radiation regulations at the *Radio'86* convention in New Orleans, LA. The September 10 seminar will cover the FCC rules, measure-

ment techniques, FM antenna patterns, occupational exposures and tower maintenance, as well as "dealing with *zoning commissions" and "public inquiries and the press."* The speakers will be: Jules Cohen, Robert Culver, Thomas Fitch, Ralph Justus, Ronald Rackley, Ruth Rosenberg, Richard Tell and Barry Umansky. Registration costs $150 for NAB members and $250 for others. Those attending *Radio'86* can save $100. For more information, contact NAB's Dept. of Science and Technology, 1771 N St., NW, Washington, DC 20036, (202) 429-5346.

MILITARY SYSTEMS

EMPRESS II Developments...The Navy has reported further delays in preparing a supplemental draft Environmental Impact Statement (EIS) on its second Electromagnetic Pulse Radiation Environment Simulator for Ships (EMPRESS II). Already more than a year overdue, the report is now scheduled for release in November; following public review, it will be revised, with the final EIS due next April, according to a Navy spokesman. The Navy, which plans to site EMPRESS II on Chesapeake Bay in Maryland, met with state officials on July 17 as part of a continuing series of discussions on its biological monitoring program. The NAVY plans to have EMPRESS II operational in 1990.

OVENS

Burn Injuries...As microwave ovens continue to grow in popularity, more and more burns will result from their misuse, warns a researcher at the Shriners Burns Institute in Cincinnati, OH. The results of a three-nation (U.S., U.K. and Canada) survey indicate that the most frequent cause of injury from microwave ovens is scalding by hot liquids or vapors — in particular, infants are injured by overheated baby bottles. "Haste and an attitude that microwave ovens *are safer...result in injury," explains Dr. Matthew Maley.* Oven manufacturers, he notes, do not include warnings about bottle burns in operating manuals and, although bottle manufacturers do warn of such dangers, many parents nevertheless heat bottles in their microwave ovens. Other causes of injuries include exploding eggs, contact with hot items and exposure to microwaves when ovens fail to shut off after their doors are opened. An 11-page report on Maley's survey findings is available from Risk Management, Shriners Burns Institute, 202 Goodman St., Cincinnati, OH 45219. A letter based on the report appeared in the May 17th issue of *The Lancet.*

Hot Scoop...The Milwaukee-based Johnston Company has done it again. Years ago it was the first commercial producer of fudge. Now, after two years of R&D, it has produced what many thought would be impossible: the microwave-able hot fudge sundae. Hot on the outside and cold on the inside, the "Hot Scoop" can go from the freezer to your lips in only 30 seconds. The sundae, available in chocolate, mint fudge and caramel, is being test-marketed in a few states and may soon be in a store near you. Can Baked Alaska be far behind?

PEOPLE

In October, Dr. **Tom Rozzell** will leave his post as manager of the Bioelectromagnetics Program at the Office of Naval Research (ONR) to become the assistant director of the Associateship Program at the National Research Council-*National Academy of Sciences. Starting 15 years ago with* a budget of only $50,000, Rozzell built the ONR program into a major source of funds for basic research — an area otherwise neglected by other federal agencies — and in 1978 he was instrumental in founding the Bioelectromagnetics Society. At the NAS-NRC, Rozzell will administer postdoctoral awards for young scientists in the life sciences at federal labs across the country. A search for his replacement at ONR is underway...Professor **Herbert Pohl** died of a heart attack on June 21 at the age of 70. Pohl taught in the Department of Physics at Oklahoma State University from 1964 to 1981 and was a visiting scientist at MIT at the time of his death. Pohl is best known for his research on the natural oscillating fields associated with living cells. He is the author of *Dielectrophoresis: The Behavior of Matter in Non-Uniform Electric Fields* (Cambridge University Press, 1978) and was the editor of the *Journal of Biological Physics.*

POWER LINES

No DC Risks in Minnesota...The majority on an expert advisory panel to the Minnesota Environmental Quality Board (MEQB) has reaffirmed its conclusion that a ±400 kV DC power line poses no risk to public safety. Six members of the panel, which first declared the line safe in December 1982, found that none of the studies appearing in the literature in 1983 and 1984 contradicted their assessment (see *MWN,* January/February 1984). The lone dissenter, Dr. Robert Brambl of the University of Minnesota in Minneapolis-St. Paul, did not participate in the recent review, telling the MEQB that the new report supported his 1982 position "...that it is more likely than not that the line represents a potentially significant hazard to human and *animal health." The majority opinion, presented in the* MEQB's report, *Comments of the MEQB Science Advisors on Electrical Environment Outside the Right of Way of CU-TR-1, Report 5,* is that "There still appears to be little likelihood that either chronic or acute exposure to small air ions and static electric fields at levels measured either on or downwind of the right of way of the DC line cause adverse health effects." The board issued *Report 5* in May 1985 as the final annual report in its five-year review of possible hazards from the Minnesota section of the Cooperative Power Association-United Power Association line, which also crosses part of North Dakota. In another report, the MEQB reported that its reanalysis of data on milk production, calving intervals and culling rates among cows living near the line supported an earlier analysis that found no significant effects. The report, *DHIA Bovine Performance and the DC Power Line,* includes more complex statistical analysis than the initial report presented, and it recommends against further study of cows. For more information, contact George Durfee of the Minnesota State Planning Agency, 100 Capitol Square Bldg., 550 Cedar St., St. Paul, MN 55101, (612) 296-2878.

STANDARDS

Power Line Noise...The International Special Committee on Radio Interference (CISPR) has released *Radio Inter-*

ference Characteristics of Overhead Power Lines and High Voltage Equipment. Part 3: Code of Practice for Minimizing the Generation of Radio Noise (Publication 18-3, 1986). The standard addresses (1) the design of power lines to control EMI to radio and television reception in the 150 kHz-300 MHz frequency range; (2) a method of predicting noise levels with a simple formula, and (3) ways of detecting and fixing loose and imperfect contacts that can spark and generate noise. It is available for $37.00 (including postage and handling) from the American National Standards Institute (ANSI), 1430 Broadway, New York, NY 10018, (212) 354-3300. *Part 2: Methods of Measurement and Procedure for Determining Limits* is due out later this year. *Part 1: Description of Phenomena* was released in 1982 and can be purchased from ANSI for $79.00, plus 7% for postage and handling....The revised version of the ANSI-IEEE 1976 standard on *Procedures for the Measurement of Radio Noise from Overhead Power Lines and Substations* (ANSI/IEEE 430-1986) was approved for publication earlier this year and should be available from ANSI soon.

ETC. . .

Summer Reading...Best-selling author and *New York Times* writer Jane Brody devoted her July 23 "Personal Health" column to the safety of microwave ovens. Her first paragraph reflects the changing attitudes toward this best-selling appliance: "Ten years ago, when my husband wanted to give me a microwave oven for our anniversary, I asked him if he was trying to get rid of me. Last Christmas, however, I bought one myself."...Veteran *Aviation Week* reporter Philip Klass has written a fascinating history of electronic warfare — see "Radar Countermeasures" in the August issue of *High Technology*....Jammers are finding a market among highway speeders, who want to confuse Smokey's radar gun. Such devices are illegal, expensive and, according to tests run by *Car and Driver* (April 1986), they don't work. The magazine recommends that those who want to go faster than 55 miles per hour should "stick with a reliable radar detector, a level head, quick reflexes and a keen pair of eyes." Certainly, sales of radar detectors continue to boom. According to an item in the July 7 *Time* magazine, 1.5 million people bought them last year, a 25% increase over 1984. A story in the August 1 *Wall Street Journal* quotes the president of Cincinnati Microwave, a leading manufacturer of radar detectors, as saying that most of his sales come on Mondays, after drivers have been nailed over the weekend....COMSAT's J.V. Evans presents a review of "Twenty Years of International Satellite Communication" in the July/August issue of *Radio Science*.

Tumor Cells in ELF Fields *(continued from p.1)*

Phillips's tumor cell studies, carried out with equipment supplied by the New York State Power Line Project, have been the object of much speculation and controversy since preliminary data were disclosed two years ago by Dr. Wendell Winters, who set up the exposure system in his lab at the University of Texas Health Science Center in San Antonio (see *MWN,* April and September 1984).

A 1984 site visit report by New York state officials raised a number of concerns about how to interpret Winters's early statements (see *MWN,* November 1984). Some of those concerns persist today. Recently, Dr. Michael Shelanski of the New York University Medical School told *Microwave News,* "I don't think I can draw any conclusions, pro or con, about implications [of the studies] on the health effects of power line fields." Shelanski, who is the chairman of the New York project's Scientific Advisory Panel, questioned the large variations in the numbers of colonies among both the exposed and control cells — one of the major criticisms cited in the 1984 site visit report.

Phillips distanced himself from Winters's 1984 statements. Addressing the variability in colony formation, Phillips countered that unexposed (control) cells did not show that much variation. "Look at the published data," he said. The variation among the exposed cells is not all that surprising, he continued, because "we don't yet know why the cells are sensitive to EMF fields."

Proliferation and Immunity

In the first set of experiments, Phillips and coworkers exposed two lines of human colon tumor cells (Colo 205 and Colo 320 DM) to 60 Hz electric (300 mA/m²) and magnetic (1.0 gauss) fields, singly and in combination, for 24 hours. Examination of the cells 7-14 days later revealed that the combined electric and magnetic fields and the magnetic field alone had significantly enhanced the number of tumor cell colonies. Also found were increased levels of tumor-associated antigens on the cells' surface. The cells exposed only to the electric field showed mixed effects.

Because the cells underwent a number of divisions over the course of the two-week experiment, the researchers suggest that the changes induced by the EMFs "are permanent and involve, therefore, an alteration of the cell's genetic information."

Next, in order to explain why the cells flourished in the field, the researchers studied how the same EMFs affected the number of transferrin receptors on their surface. Transferrin is a protein which transports iron and other metals through the cell membrane by binding to surface receptors; the number of receptors has been associated with cell proliferation.

Four, six and eight months after the same type of 24-hour exposure to the combined fields and to the magnetic field alone, cells had more transferrin receptors — approaching or exceeding the maximum possible number predicted by theoretical models. The ability of transferrin to bind with its receptor was unchanged. Those cells exposed only to the electric field, on the other hand, had fewer receptors than expected.

Here again, the exposed cell colonies multiplied prodigiously — up to a 24-fold increase relative to controls — and continued to do so eight months after exposure.

The normal regulatory systems had clearly stopped func-

tioning. Phillips's team again concluded that the EMFs had caused some basic and permanent change in the way the cells functioned.

In the third series of experiments, they examined the ability of human lymphocytes (natural killer cells) to destroy the EMF-exposed tumor cells, and they unexpectedly found that destruction of electromagnetic and magnetic field-exposed tumor cells "dramatically decreased."

Previous studies have indicated a relationship between the number of transferrin receptors and susceptibility to attack by lymphocytes, and so it is not clear why the cells with the largest number of receptors did not succumb to the lymphocytes. Nevertheless, their immunity enhances the general ability of the tumor cells to thrive after EMF exposure, further supporting the role of magnetic fields in cancer promotion.

Replication Underway

Dr. Maimon Cohen of the University of Maryland School of Medicine in Baltimore has begun work on a replication study of these experiments under a grant from the New York State Power Line Project. The project had originally asked Dr. Gordon Livingston of the University of Utah in Salt Lake City to attempt the replication (see *MWN*, October 1984) but, according to Shelanski, that study did not work out.

References

Jerry L. Phillips, Wendell D. Winters and Loyce Rutledge, "*In Vitro* Exposure to Electromagnetic Fields: Changes in Tumor Cell Properties," *International Journal of Radiation Biology, 49,* pp.463-469, 1986.

Jerry L. Phillips, Loyce Rutledge and Wendell D. Winters, "Transferrin Binding to Two Human Colon Carcinoma Cell Lines: Characterization and Effect of 60 Hz Fields," *Cancer Research, 46,* pp.239-244, 1986.

Jerry L. Phillips, "Transferrin Receptors and Natural Killer Cell Lysis: A Study Using Colo 205 Cells Exposed to 60 Hz Electromagnetic Fields," *Immunology Letters* (in press).

Workers Claim Radar Accident *(continued from p.1)*

OSHA Could Not Substantiate Accident

A complaint was filed with the Occupational Safety and Health Administration (OSHA), but OSHA inspectors were unable to determine whether the radar had been turned on. William Masters, OSHA's area director for the state of Maine, said that no violation could be substantiated for radiation overexposure but a citation was issued for failure to post enough RF radiation hazard caution signs. During the same inspection, BIW was cited for not having a guardrail on one crane.

The citation for the lack of radiation signs does not entail a fine; the guardrail violation carries a $640 penalty. BIW did not contest either citation and will pay the fine, according to an OSHA spokesman.

Dennis Brillant, who was operating a crane and was at the same height as the radar, complains of lasting injuries and has not returned to work since the accident. Brillant referred questions about his condition to his attorney, Jonathan Reitman of Brunswick, ME, who did not answer requests for comment.

A source familiar with Brillant's condition told *Microwave News* that Brillant is often disoriented and that his short-term memory is impaired. Brillant has constant headaches and must take medication to dull the pain: "He is not the same man as he was before March 19," said the source, who requested anonymity. These symptoms are similar to those reported by the men involved in the radar accident at Clear Air Station in Alaska (see *MWN,* November 1983 and September/October 1985).

The Workers' Accounts

Notes written by two other crane operators describe how they felt at the time of the incident:

Joe Chagnon: "On March 19, 1986, around 7:10-7:15 [a.m.], I called my foreman and told him I was coming out of the crane and going to first aid, because I had a headache. When I got to first aid, my head felt like it was going to blow up. The nurse said my face and neck were bright red. She checked me out and said my blood pressure was up and [I had a high pulse rate and a] fever. First aid told me to go to the hospital...The doctor also took pictures of my neck and right shoulder."

Paul Gosselin: "About 07:20, I experienced a tremendous headache and a burning sensation about my face, eyes and neck. I also felt weird all over. This seem[ed] to come in a matter of minutes. It also set off alarms in the drydock. At about 07:45, I went to first aid where elevated blood pressure was detected and also rapid pulse..."

BIW Report Due

BIW is preparing a report on the March 19 incident. Jim McGregor, BIW's director of public relations, told *Microwave News* that the report would be released on August 12 – although he had said previously that it would be available the first week of July. Asked about the delay, he said, "We want to make absolutely certain that the radar functioned properly and that whatever medical problems were reported were not caused by the radar."

A March 21 internal BIW memorandum obtained by *Microwave News* states that tests of the SPS-49 radar carried out that day produced "no discernible readings" on a "RADHAZ" meter.

Local 6's Mackie said that he remembers another accident a few years ago. But McGregor said that previous allegations of radar exposures had proved negative.

Dr. Jennifer Christian, an industrial hygienist at BIW, called many experts on the health effects of radar radiation after the accident, but she declined to be interviewed for this article.

The Navy did not respond to requests for comment.

CONFERENCES

Upcoming Meetings

September 8-11: **16th European Microwave Conference,** National Concert Hall, Dublin, Ireland. Contact: Microwave Exhibitions & Publishers, Convex House, 43 Dudley Rd., Tunbridge Wells, Kent TN1 1LE, U.K.

September 11-13: **Scientific Conference on Electropathology,** Physiologisches Institut der Universitat Freiburg, Federal Republic of Germany (F.R.G.). Contact: Conference Secretariat, Forschungsselle fur Elekktropathlogie, Reutebachgasse 11, D-7800 Freiburg, F.R.G., (0761) 56201.

September 13-16: **39th Annual Conference on Engineering in Medicine and Biology,** Marriott Hunt Valley Inn, Baltimore, MD. Contact: Susan Leone, Suite 700, 1101 Connecticut Ave., NW, Washington, DC 20036, (202) 857-1199.

September 14-19: **1986 IEEE/PES Transmission and Distribution Conference and Exposition,** Convention Center, Anaheim, CA. Contact: Charles White, South Carolina Electric and Gas Co., PO Box 764, Columbia, SC 29218, (803) 748-3518.

September 16-18: **IEEE International Symposium on Electromagnetic Compatibility,** Town and Country Hotel, San Diego, CA. Contact: George Ufen, GRU Associates, 1105 East Commonwealth Ave., Fullerton, CA 92631, (714) 738-0903.

September 17-19: **International Utility Symposium on the Health Effects of Electrical and Magnetic Fields: Research, Communication and Regulation,** Constellation Hotel, Toronto, Ontario, Canada. Contact: John O'Grady, Ontario Hydro, Suite H8 D4, 700 University Ave., Toronto, Ontario M5G 1X6, Canada, (416) 592-3395.

September 17-19: **1986 Symposium on Antenna Applications,** Allerton House, Monticello, IL. Contact: Paul E. Mayes, Dept. of Electrical and Computer Engineering, University of Illinois, 1406 W. Green St., Urbana, IL 61801, (217) 244-0543.

September 21-24: **3rd Congress of the European Society of Magnetic Resonance in Medicine and Biology,** University of Aberdeen, Scotland. Contact: Dr. Margaret A. Foster, Dept. of Biomedical Physics and Bioengineering, University of Aberdeen, Foresterhill, Aberdeen AB9 2ZD, Scotland, U.K., (0224) 681818, ext.3208.

September 22-25: **8th European Hyperthermic Oncology Scientific Meeting,** Rehovot-Tiberias, Israel. Contact: Dr. A. Yerushalmi, Dept. of Cell Biology, The Weizmann Institute of Science, Rehovot 76100, Israel.

September 23-25: **8th Annual Meeting and Symposium of the Antenna Measurement Techniques Association,** Westin Hotel, Ottawa, Ontario, Canada. Contact: Laurier Forget, National Research Council, Ottawa, Ontario K1A 0R6, Canada, (613) 993-9009.

September 23-25: **8th Annual Electrical Overstress/Electrostatic Discharge Symposium,** Riviera Hotel, Las Vegas, NV. Contact: Michael Martin, 3M/Static Control Systems Div., 2111 W. Braker Lane, Bldg. 501, PO Box 2963, Austin, TX 78769, (512) 834-3117.

September 23-26: **Heating and Processing: 1-3000 MHz,** Cambridge, U.K. Contact: British National Committee for Electroheat, 30 Millbank, London SWIP 4RD, U.K.

September 29-October 3: **Montech'86: IEEE Week in Montreal,** Convention Center, Montreal, Quebec, Canada. Includes: Sept. 29-Oct. 2: **Conference on Antennas and Communications,** chaired by Dr. A. Kumar, (514) 457-2150; Sept. 29-Oct. 2: **Conference on HVDC Power Transmission,** chaired by Dr. P.C.S. Krishnayya, (514) 652-8342; Oct. 1-3: **Conference on AC Power Systems,** chaired by Gilles Baril, (514) 652-8212; Oct. 1-3: **Conference on Electrothermal Processes,** chaired by Edward Goodman, (514) 652-8546. General conference address: PO Box 37, Station "A," Montreal, Quebec H3C 1C5, Canada.

September 30-October 3: **5th International Conference and Tutorial Day on Electromagnetic Compatibility,** University of York, U.K. Contact: The Conference Secretariat, IERE, 99 Gower St., London WC1E 6AZ, U.K., (01) 388-3071.

October 6-7: **2nd International Conference on Harmonics in Power Systems,** Winnipeg, Manitoba, Canada. Contact: Robert Hamlin, Room 227, Engineering Bldg., University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada, (204) 261-4412.

October 6-12: **1st International School: Electromagnetic Fields and Biomembranes,** Pleven, Bulgaria. Contact: Professor Marko Markov, Dept. of Biophysics and Radiobiology, Sofia University, 8 Dragan Tzankov Blvd., Sofia 1000, Bulgaria.

October 14-16: **1st National Convention of the Society of Broadcast Engineers (SBE),** A.J. Cervantes Convention Center, St. Louis, MO. Contact: SBE National Convention, PO Box 16861, St. Louis, MO 63105, (314) 725-2184.

October 19-22: **6th Annual Meeting of the Bioelectrical Repair and Growth Society (BRAGS),** Utrecht, Holland. Contact: BRAGS, PO Box 64, Dresher, PA 19025, (215) 659-5180.

October 20-24: **11th IEEE International Conference on Infrared and Millimeter Waves,** Hotel Continental, Pisa, Italy. Contact: M. Inguscio, Dept. of Physics, University of Pisa, Piazza Torricelli 2, I-56100 Pisa, Italy, (050) 45222.

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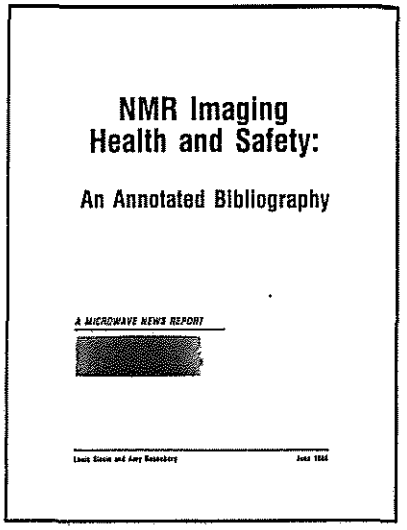
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NY State Power Lines Report: ELF Risks Gain National Attention

The New York State Power Lines Project's scientific advisory panel has accepted and endorsed the findings of the Savitz study, noting that they add "to the credibility of the [Wertheimer-Leeper] hypothesis that exposure to extremely low frequency [ELF] magnetic fields might be a cause of childhood cancer."

In its final report, the panel distanced itself from endorsing a "causal relationship" between power line magnetic fields and cancer, however – arguing that it is "still no more than a hypothesis," albeit a "stronger" one now. If a causal relationship does exist, the panel estimated that "10-15% of all childhood cancer cases are attributable to magnetic fields."

While bemoaning the absence of a mechanism to explain the action of the magnetic fields, the panel underlined how small the implicated fields are: "One might be exposed to such fields almost anywhere in the environment."

Overall, the panel concluded that the 16 funded studies indicated a "variety of effects" not "previously appreciated" and that, "Several areas of potential concern for public health have been identified." One particular result that has sparked special interest is Dr. Kurt Salzinger's experimental finding of long-term behavioral effects from pre- and post-natal exposure to ELF fields (see p.6). The panel singled out this effect, calling it "dramatic," and said that it is in specific need of replication.

(continued on p.7)

Congress To Hold Hearings

The House Subcommittee on Water and Power Resources plans to hold hearings on the potential health risks associated with exposure to power line electromagnetic fields when Congress reconvenes in the fall. The subcommittee is chaired by George Miller, Democrat of California.

The hearings are prompted by the New York State report, a subcommittee aide told *Microwave News*. She added that Congressman Miller – who also chairs the Select Committee on Children, Youth and Families – is particularly concerned about the potential cancer threat to children.

The hearings were tentatively scheduled for mid-September. At press time, no decision had been reached on who will be invited to testify.

HIGHLIGHTS

The Talk of BEMS

The action started early at this year's Bioelectromagnetics Society (BEMS) conference.* In his introductory remarks at the opening session, Dr. Ross Adey digressed to lash out at Drs. Ken Foster and Bill Guy for their "flight of fancy" in ignoring all but thermal effects in their article on microwaves in *Scientific American* (see *MWN*, November/December 1986): "We have a responsibility, individually and collectively as a society, to communicate athermal effects to society and lawmakers," Adey said, noting the irony that the next four speakers would address the detection of weak electromagnetic fields for navigation and orientation.

Moments later, John Mitchell, Dr. Dave Erwin and Dr. Jonathan Kiel, all of the U.S. Air Force walked out of the ballroom, together with Foster, Dr. Eleanor Adair of the John B. Pierce Foundation and Dr. John Bergeron of GE. Foster refused to talk about his protest. Others were more forthcoming: "It went beyond the privilege of chairing a session," Erwin told *Microwave News*. For his part, Bergeron said he was "responding personally to something that was totally inappropriate."

Few in the audience were without an opinion. Many thought that Adey had chosen the wrong time to pick a fight, but Dr. Steve Baumann of Northrop Services, Inc., expressed a view shared by many when he said that he thought Adey's remarks were "particularly appropriate," because *Scientific American* is perceived as the arbiter of "what is valid in science."

*****

Henry Kues of the Johns Hopkins University Applied Physics Lab and Jack Monahan of the Food and Drug Administration presented startling new evidence of damage to the corneal endothelial layer of a monkey's eye caused by microwaves acting alone and in combination with drugs (see *MWN*, September/October 1986). The lesions on the surface of the cornea – a crater-marked landscape – are clearly visible in Kues and Monahan's photographs, leading them to suggest that this effect could be used as a diagnostic technique for acute overexposure to microwaves.

Kues and Monahan stressed that you have to look for the lesions. "I asked an ophthalmologist to examine some exposed and control eyes of live monkeys and, after a slit-lamp examination, he pronounced them normal," Kues said during a break at the meeting. "He was amazed when I showed him the lesions. He could not believe he had missed them."

Kues and Monahan found that pulsed microwaves can cause changes at an SAR of 2.6 W/Kg. But if the eye is first treated with drugs used in glaucoma therapy, the threshold is reduced to less than 1.3 W/Kg. Surprisingly, they have found the same action with two different drugs – timolol maleate and pilocarpine – that act in opposite ways to relieve the intraocular pressure associated with glaucoma. They were quick to point out that some two million Americans take these glaucoma drugs on a regular basis.

The mechanism of interaction is not yet clear, but Kues and Monahan have shown that the blood barrier in the eye leaks following radiation exposure. They speculated that transferrin, a catalyst for the formation of superoxides, may be passing through the barrier and causing the damage to the corneal endothelial layer.

The next step, Kues and Monahan said, is to look at the effects of microwaves on the blood barrier in the brain. They plan to begin those experiments soon.

*****

In the past, speakers from the floor were likely to ask whether temperature changes had been measured following radiation exposure or SARs had been calculated. This year, there were many more questions as to whether researchers had measured the local geomagnetic field.

Dr. Abe Liboff of Oakland University and Dr. Bruce McLeod of Montana State University, along with Dr. Carl Blackman of the Environmental Protection Agency, are largely responsible for this new trend. In Portland, Liboff and McLeod reviewed three sets of experimental data – on rats, diatoms and lymphocytes – which agreed with their *a priori* predictions based on their cyclotron resonance model.

Cyclotron resonances have come a long way as a predictor of bioelectromagnetic interactions, yet many of the early arguments against them still need answers. As Dr. Charles Polk of the University of Rhode Island explained, complications arise due to both collisions among particles and the "smearing out" of the resonances as the target moves in the magnetic field.

Skepticism still abounds. Nevertheless, few took issue with Liboff and McLeod when they said that the data "suggest very strongly that we are on the right path."

Dr. Carl Durney of the University of Utah also scored a success with his new model of the movement of a charged particle in combined DC and AC magnetic fields. The model is extremely simple, but it does, under the right conditions, predict both frequency and amplitude windows, similar to those found by Adey and Blackman in their work on calcium efflux.

*The *9th Annual Meeting of the Bioelectromagnetics Society* (BEMS) was held June 21-25 in Portland, OR.

PMFs Again Linked to Abnormal Pregnancies in Mice

New experimental data from Sweden support last year's finding that VDT-type radiation can upset fetal development in mice. Professor Gunnar Walinder and coworkers at the Swedish University of Agricultural Sciences in Uppsala have found a significant increase in fetal deaths and resorptions (fetal losses) among pregnant mice exposed to weak pulsed magnetic fields (PMFs), as compared to controls. The offspring of the exposed mice also had a higher incidence of malformations, though this finding is not statistically significant.

Last year, a group headed by Professor Bernhard Tribukait of the Department of Medical Radiobiology at the prestigious Karolinska Institute in Stockholm reported a significant increase in external malformations among mice exposed to VDT-type radiation (see *MWN*, March/April and May/June 1986).

The different results from the Uppsala and Karolinska studies may be due to the fact that the experiments used different strains of mice and different lengths of exposure: "They are not contradictory," Tribukait told *Microwave News* from his lab in Stockholm. "In general, it is the same effect." He added, "It is rather clear that the [PMF] effect is real."

Walinder, who heads the Radiobiological Oncology Unit at the agricultural university, agrees that the PMFs have an effect on the mice embryos, but does not think that the two sets of results are "consistent." In a telephone interview from Uppsala, Walinder hypothesized that the PMF exposures may cause increased fetal implantations and that these added fetuses are not surviving: "We are seeing a very early effect that makes animals more susceptible to implantation. Embryos that are normally rejected by the mice were accepted."

The Uppsala team exposed "CBA/s" mice to sawtooth PMFs for the first 19 days of pregnancy, after which the mice were killed; the Karolinska group exposed "C3H" mice for the first 14 days of pregnancy – these mice were killed on the 19th day.*

In the Uppsala study, there were increases in fetal death (2.3% v. 0.98%) and resorptions (10.67% v. 5.55%) among exposed mice, compared to unexposed controls, as well as a non-significant rise in malformations (see table on p.4). In the Karolinska study, there was a significant increase in serious malformations (1.9% v. 0.2%), but not in fetal deaths or resorptions.

"One possible explanation is that the malformed animals might have been killed during the longer exposure period," Tribukait suggested. Similarly, Dr. Kjell Hansson Mild of the Swedish National Board of Occupational Safety and Health in Umea reasoned, "The extra days of exposure may be causing the extra deaths." Most of the dead malformed fetuses in the Uppsala study had multiple malformations. In a related study, Mild and Dr. Ingrid Nordenson of Umea University have found genetic effects due to PMFs (see box on left).

The Uppsala mice study used the same type of radiation as that used in the Karolinska study: a 20 kHz sawtooth magnetic field with an intensity of 15 microtesla. The pulse had a rise time of 45 microseconds (μsec) and a fall time of 5 μsec. The shape and frequency of the pulses were designed to mimic emissions from video display terminals (VDTs).

In contrast to the active research program in Sweden, most U.S. experts have largely ignored the Karolinska results and continue to dismiss the risks associated with VDT radiation. No U.S. labs are attempting to repeat the mice experiment, largely due to the dearth of research funds.

At the Food and Drug Administration (FDA), scientists are watching the VDT studies and their "implications for public health," according to Roger Schneider, the associate director for science at the FDA's Center for Devices and Radiological Health in Rockville, MD. The FDA, which has the authority to regulate VDT radiation

PMFs: Chromosomal Changes

Dr. Ingrid Nordenson of the Department of Medical Genetics at Sweden's Umea University and Dr. Kjell Hansson Mild of the Swedish National Board of Occupational Safety and Health in Umea have found preliminary indications that VDT-type PMFs can cause genetic effects in exposed tissue samples.

In a poster paper presented at the Bioelectromagnetics Society meeting in Portland, OR, in June, Nordenson and Mild wrote that human amniotic cells exposed to 20 kHz sawtooth magnetic fields with intensities of up to 16 μT (peak-to-peak) for three days showed "significant increases in the frequency of aberrations in exposed cells compared to controls." Similar effects were seen among cells exposed to 30 μT sinusoidal 50 Hz fields for three days.

Nordenson and Mild noted that there was considerable inter-experimental variation in the results and that the "implications for human health were unclear." The work will expand: They plan to investigate PMF-induced oncogene expression and to study tissue samples from the Karolinska and Uppsala mice exposed to PMFs.

*The Uppsala and Karolinska teams used different systems to number the days in their experiments. Each lasted a total of 19 days. The Karolinska group called the first day, "day 0," and the last day, "day 18."

EFFECTS OF PMFs ON MICE: Uppsala Experimental Results

	PMF-Exposed	*Controls*
No. of female mice	245	173
No. of pregnant females	211 (86.1%)	154 (89.0%)
No. of non-pregnant females	34 (13.88%)	19 (10.98%)
No. of implantations	1,753	1,190
No. of resorptions	187 (10.67%)	66 (5.55%)
No. of live fetuses	1,530 (97.7%)	1,113 (99.0%)
No. of dead fetuses	36 (2.3%)	11 (0.98%)
Weight of live fetuses (gram)	0.957 ±0.003	0.947 ±0.003
Length of live fetuses (mm)	19.58 ±0.03	19.51 ±0.03
No. of Live Malformed Fetuses	16 (1.05%)	8 (0.72%)
No. of Malformations	21	13
No. of Dead Malformed Fetuses	5 (13.89%)	2 (18.18%)
No. of Malformations	13	2

emissions, has only a small research program on the biological effects of non-ionizing electromagnetic fields. Schneider noted that, "The FDA cannot afford to study VDTs separately from microwave ovens, diathermy or other types of electronic products."

Dr. Przemyslaw Czerski, also of the FDA, expressed a keen interest in the Swedish experiments and told *Microwave News* that reciprocal visits between agency scientists and the Swedish researchers are desirable and are being explored.

A number of scientists at the Environmental Protection Agency (EPA) are also monitoring the new developments, even though the agency is no longer doing any research on non-ionizing radiation. Dr. Ezra Berman, an EPA teratologist, commented that, "Although this [new] experiment shows early death while the previous one showed malformations, the interesting thing is they both show effects. That similarity should be examined further."

EPA's Dr. Carl Blackman is interested in exploring the possible effects of variations in the earth's magnetic field – these may provide clues to explain the differences in the observed experimental results, he suggested.

Berman is coordinating an international project to explore the effects of PMFs on chick embryos – a finding first reported by Dr. Jocelyne Leal of the Centro Ramon y Cajal Hospital in Madrid, Spain (see *MWN*, March 1983 and January/ February 1986). Preliminary results from the six participating labs – including Mild's and Leal's – are expected by the end of the year.

Walinder, Tribukait and Mild all agree that the PMF experiments must continue. "We cannot stop at this stage," Mild said. Walinder concurred, noting that he is "not convinced" that the effect is well understood. Plans for new studies are already underway. In his next experiment, Walinder will expose mice beginning on the fourth or fifth day of pregnancy to test his hypothesis concerning the effect on the frequency of implantation. He will also look for brain damage among the fetuses – which he called a more sensitive indicator of an effect.

Tribukait intends to run his next experiment at higher frequencies – at 40 kHz and, possibly, at 60 kHz. In addition, he would like to repeat his original study using the same strain of mice used by the Uppsala group. Walinder said that he is reluctant to use the Karolinska mice due to the risk of infection. On the other hand, Tribukait said that he is not worried about infections because the strains can be isolated from each other.

Tribukait is in the process of preparing a paper, which he intends to submit to the *International Journal of Radiation Biology*. Walinder wants to complete his next set of experiments before publishing his results.

The results of the Uppsala study were released in Sweden in June without fanfare; they have received little attention in the Swedish press.

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DNA MW Absorption Contested

Researchers at two independent labs in England and Sweden have failed to replicate experiments showing that aqueous solutions of DNA can absorb microwaves in the 1-10 GHz frequency band. Professor Edward Grant and coworkers at King's College, London, and Drs. B. Gestblom and E. Noreland of Uppsala University were unable to document any resonances or "any form of enhanced absorption." The new results appear in the July 9 issue of *Nature* (*328*, pp.145-146, 1987).

The absorption of microwaves by DNA was predicted by the theoretical work of Drs. Earl Prohofsky and Lonnie Van Zandt of Purdue University in West Lafayette, IN, and was first shown experimentally by Drs. Glenn Edwards and Chris Davis of the University of Maryland in College Park, Dr. Jeffrey Saffer of the National Cancer Institute in Bethesda, MD, and Dr. Mays Swicord of the Food and Drug Administration in Rockville, MD.

In a series of telephone interviews, U.S. researchers suggested two possible explanations for the lack of experimental agreement: variations in the DNA samples and/or differences in the sensitivity of the measurement techniques.

Edwards, who is now at Vanderbilt University in Nashville, TN, noted that, "Grant's paper failed to report the quality of the DNA sample or the ability of his technique to resolve small differences in dielectric properties."

Davis also remains confident that the microwave effect is real: "We have been trying to generate artifactual data to explain away our results, but we cannot." He said that producing the DNA samples is "not trivial," adding that the disagreement in experimental results may be due to "some subtleties in the samples."

Speaking from London, Grant stressed that his DNA "was prepared in exactly the same way" as the Maryland group's DNA. In fact, he said, a biochemist had gone to the U.S. to learn the technique.

The European researchers used time domain spectroscopy with pulsed radiation, while the Americans used a frequency domain technique with continuous wave microwaves. Grant argued that the two methods were identical and that the DNA samples "should not react differently" to the two types of radiation. As added proof, he pointed out that the Swedish group had also taken some frequency domain measurements and that these agreed with their time domain results. Grant said that these data were not included in the *Nature* paper, but would be cited in a future publication, now in preparation.

There will soon be added support for the negative results from Europe. Dr. Ken Foster of the University of Pennsylvania in Philadelphia – working with Dr. Michael Gealt of Drexel University, also in Philadelphia, and with Dr. Benjamin Epstein of the David Sarnoff Labs in Princeton, NJ – has failed to detect any DNA resonances, using the same measurement technique as Edwards did, but he did succeed in generating artifactual resonances. Foster told *Microwave News* that the magnitude of Edwards's resonances was much smaller than the errors specified by the manufacturer of the probe. "It's like trying to weigh an airmail letter with a bathroom scale," he said. These new results will appear in the September issue of the *Biophysical Journal*.

Edwards countered that it is easy to generate false resonances. "However, if the system is correctly calibrated," he said, "such artifacts will not occur."

For his part, Van Zandt maintains that the enhanced absorption is predicted by his theoretical work. "Maybe Glenn Edwards did not see it," he said, "but according to my calculations, there is a good chance he did."

The research is continuing on both sides of the Atlantic. Grant said that his next set of experiments will be run at lower frequencies – in the kHz range. These studies will be carried out in collaboration with Professor M. Mandel of the University of Leiden in Holland. Mandel, a physical chemist, is an expert on the dielectric properties of DNA. In addition, Grant said that he will run the experiment with frozen DNA.

In a month, Davis's group will start a new series of experiments using fresh DNA samples and a new measurement system. Edwards is also continuing his studies.

As the arguments about whether DNA in solution can absorb microwave energy continue, Saffer, who is now at the Jackson Laboratory in Bar Harbor, ME, is investigating what he calls the "biological significance" of these resonances under a recent $343,000 contract with the Office of Naval Research (ONR).

In preliminary experiments, Saffer has already shown that irradiation with 2-4 GHz microwaves can cause enhanced gene expression of plasmid DNA in *E. coli*. He admits that he is not certain that the radiation affects the DNA – it may change RNA translation – but he is sure that he is not observing a thermal effect because heat causes a decrease in expression.

Interestingly, much of the U.S. work on DNA absorption is being supported by the U.S. Navy, through ONR, while the English and Swedish work is being paid for by the U.S. Air Force.

See also L.L. Van Zandt, "Resonant Microwave Absorption by Dissolved DNA," *Physical Review Letters, 57*, pp.2085-2087, October 20, 1986; John Maddox, "Physicists About To Hi-Jack DNA?," *Nature, 324*, p.11, November 6, 1986; J.W. Powell et al. (including Edwards and F. Kremer), "Investigation of Far-Infrared Vibrational Modes in Polynucleotides," *Physical Review A, 35*, pp.3929-3939, May 1, 1987; Maxim Frank-Kamenetskii, "Physicists Retreat Again," *Nature, 328*, p.108, July 9, 1987; and *MWN*, May and November 1984, March and June 1985 and May/June 1987.

ANSI Too High? A Thermal View

Many people – citing non-thermal effects of radiofrequency and microwave (RF/MW) radiation – have argued that the widely used American National Standards Institute (ANSI) safety standard is too lax. Now, Dr. Christopher Gordon of the Environmental Protection Agency (EPA) makes the same case but only on the basis of thermal effects.

Writing in the most recent issue of *Bioelectromagnetics* (*8*, pp.111-118, 1987), Gordon argues that human health protection standards are incorrectly derived from animal data – by simply extrapolating to a larger weight. Gordon believes that RF/MW thermal effects should be scaled on the basis of whole-body surface area not whole-body mass, because the ability of mammals to dissipate heat decreases with increasing mass but is independent of surface area. According to his calculations, the ANSI standard of 0.4 W/Kg would translate into 0.06 W/Kg, an exposure level of approximately 150 $\mu W/cm^2$, if keyed to surface area rather than body mass.

Gordon's coworkers at the EPA's Health Effects Research Lab in Research Triangle Park, NC, have found that the threshold for thermal effects should be 1 W/Kg (see *MWN*, January/February 1984). In its draft criteria document on RF/MW radiation, the National Institute for Occupational Safety and Health (NIOSH) proposed a 2 W/Kg threshold (see *MWN*, July/August 1985). Using ANSI's safety factor of ten and scaling by surface area, the EPA and NIOSH standards would be 0.015 and 0.03 W/Kg, respectively, the equivalent of 38 and 75 $\mu W/cm^2$.

"I expect there will be a lot of discussion of Gordon's paper in the bioelectromagnetics community," predicts EPA's Dr. Joe Elder, who edited the agency's 1984 review of RF/MW bioeffects.

EPA's non-ionizing radiation research program has been closed down; Gordon is now doing research on toxic chemicals (see *MWN*, September/October 1986).

ELF NEWS

Long-Term ELF Behavioral Effect

Adult rats previously exposed to 60 Hz electric and magnetic fields in the womb and for the first few days of life responded to behavioral conditioning significantly more slowly than unexposed controls, according to Professor Kurt Salzinger of Polytechnic University in Brooklyn, NY. This is a "lasting effect that cannot be ignored," Salzinger told *Microwave News*.

Salzinger and coworkers exposed pregnant rats to 60 Hz, 30 kV/m electric and 1 G magnetic fields for their entire gestation period; the offspring were then exposed for the first eight days of life. When they were 90 days old, the male offspring were extensively trained on a random-interval reinforcement schedule and their responses were measured. The study was sponsored by the New York State Power Lines Project.

A key finding is that the rats' delayed responses were observed long after their exposure to ELF fields and after a good deal of conditioning. Indeed, in his report, Salzinger points out that "the effect might not have been found if we had been content to look only for immediate effects." The response rate of the exposed rats decreased up to 20%, as compared to controls.

In a telephone interview, Salzinger said that the effect was "robust" and "permanent," but that it was not yet clear whether the disability developed over time or after training. "We want to do more studies in which we train the rats earlier in order to separate out these two possibilities," he added.

Salzinger drew an analogy between the rats' behavioral defect and dyslexia, a reading disability. "You can only tell there is a problem when children start learning to read, and then you need a sensitive test," he said. Similarly, the rats' disability only became apparent when they were adults. Salzinger's final report notes that none of the exposed rats showed any differences in physical appearance, in activity level, in weight or in incidence of disease.

Salzinger and his collaborators – including Leo Birenbaum, Dr. Steven Freimark, Dr. Malcolm McCullough and Donald Phillips – also exposed rats to fields of 10 kV/m and 0.33 G and compared them to others exposed to 30 kV/m and 1 G. The less-exposed group showed less of an effect, but the difference was not statistically significant.

Like most of the other New York State researchers, Salzinger has been unable to raise any funds since the New York power line money ran out. "I've just about given up trying," he said. Salzinger, who is with the Department of Social Sciences at Polytechnic University, is a past president of the New York Academy of Sciences.

EPRI Funds Two New Occupational Studies

The Electric Power Research Institute (EPRI) has funded two new projects: (1) a feasibility study for a large-scale epidemiological survey of the risk of leukemia, particularly acute non-lymphocytic leukemia (ANLL), and primary brain cancer among utility workers exposed to electric and magnetic fields; and (2) an assessment of occupational exposures to power line fields.

In July, Dr. David Savitz of the University of North Carolina in Chapel Hill and J. Michael Silva of Enertech Consultants, Inc., in Sunnyvale, CA, began examining utilities for a suitable population for a case-control epidemiological study. By the time this first phase is completed in December 1988, Savitz and Silva will have both identified a utility to participate in the study and developed a tentative system to classify exposures by job title.

Savitz will also run a pilot mortality follow-up study of approximately 3,000 workers to ensure that enough cancer cases will be generated in the full-scale study. And Silva will measure both occupational and non-occupational electromagnetic exposures.

The proposed study will be designed to detect a relative risk of 2.0 for ANLL and primary brain cancers.

Dr. Joseph Bowman of the University of Southern California in Los Angeles is the principal investigator on the second study, which will test the validity of occupational titles as surrogates for actual measurement of electric and magnetic fields. Bowman is already collaborating with Dr. John Peters on an epidemiological study to test the Wertheimer-Leeper finding of a link between childhood leukemia and ELF fields (see *MWN*, November/ December 1986).

The exposure assessments will be based primarily on data from portable dosimeters. EPRI has specified the use of the dosimeter developed by IREQ, the research arm of Hydro-Quebec (see *MWN*, September/October 1986). Bowman will also collect data on other potential chemical and physical contaminants.

In a related development, Dr. Charles Rafferty, who has been filling in for Dr. Tom Rozzell at the Office of Naval Research, has joined EPRI as a project manager in the non-ionizing radiation sub-program.

NY Power Lines Project Report *(continued from p.1)*

The release of the New York panel report generated headlines in newspapers all over the world, focusing attention on the health risks associated with living next to power lines. The report has been in great demand; 600 copies have already been distributed and another 500 have been printed. A month after the report was issued, Dr. David Carpenter of the New York Department of Health, who served as the executive secretary of the panel, said that he was still getting five to ten calls a day from reporters. Congress plans to hold hearings in September (see box on p.1).

The panel avoided suggesting how wide right-of-ways should be next to power lines, but did recommend a "major research effort" to reduce exposures to magnetic fields associated with power delivery. Calling more research on the biological effects of electromagnetic fields "very important," the panel specifically suggested a search for thresholds for magnetic field effects and further extensive studies on the potential cancer link (see pp.8-10 for the full text of the panel's summary and recommendations).

In contrast to the current situation in which essentially all funds for ELF bioeffects research come from the Department of Energy (DOE) and from the Electric Power Research Institute (EPRI), the panel advocated that research be "administered by an agency, preferably federal, which is credible by virtue of being clearly independent of partisan influence." Carpenter told *Microwave News* that the intent of this recommendation was not to end DOE and EPRI support but to encourage others to join the research effort. Carpenter singled out the National Institutes of Health (NIH) as one agency that should participate.

The panel issued its report in July – six years after it was constituted to spend $5 million to investigate ELF health effects, eight years after Dr. Nancy Wertheimer and Ed Leeper published their epidemiological study first linking magnetic fields to childhood cancer and 14 years after applications were filed to build 765 kV power lines in NY state, touching off a controversy that led to the project. Dr. David Savitz of the University of North Carolina in Chapel Hill first announced his study results last November (see *MWN*, November/December 1986).

Many of the key findings of the NY studies have already been reported. These include:

- The proliferation of human tumor cells exposed to ELF fields (see *MWN*, April and September 1984 and July/ August 1986). These results, by Drs. Wendell Winters and Jerry Phillips, were not replicated by Dr. Maimon Cohen in a follow-up study also funded by the project, after the Winters-Phillips results were publicized. A dispute is brewing over whether Cohen followed the same experimental procedures. (This will be addressed in a future issue.)
- Dramatic behavioral effects in rats exposed to weak ELF fields in a static field less than that of the earth's, demon-

NY Power Lines Project Reports

Prasanta K. Basu, *Biological Effects of Extremely Low Frequency Electric and Magnetic Fields on the Ocular Tissues: An In Vitro Study*, 112 pp., $28.00.

Arland L. Carsten, *Mutagenicity and Toxicity of Electric and Magnetic Fields*, 196 pp., $49.50.

Maimon M. Cohen, *In Vitro Genetic Effects of Electromagnetic Fields*, 100 pp., $25.00.

Maimon M. Cohen, *The Effects of Low-Level Electromagnetic Fields on Cloning of Two Human Cancer Cell Lines (Colo 205 and Colo 320)*, 34 pp., $8.50.

Amos G. Gona, *Effects of 60 Hz Electric and Magnetic Fields on the Developing Rat Brain*, 40 pp., $10.00.

Charles Graham and Harvey D. Cohen, *Influence of 60 Hz Fields on Human Behavior Physiology Biochemistry*, 102 pp., $25.50.

Ross Gundersen, Ben Greenebaum and Eugene Goodman, *Effects of 60 Hz Electromagnetic Fields on Calcium Efflux and Neurotransmitter Release*, 46 pp., $11.50.

Gordon K. Livingston, *Reproductive Integrity of Mammalian Cells Exposed to 60 Hz Electromagnetic Fields*, 45 pp., $11.25.

Klaus-Peter Ossenkopp, *ELF Low Intensity Magnetic Fields and Epilepsy*, 52 pp., $18.25.

Gideon A. Rodan, *Effect of 60 Hz Electric and Magnetic Fields on Neural and Skeletal Cells in Culture*, 40 pp., $10.00.

Kurt Salzinger, *Behavioral Effects of ELF*, 137 pp., $34.00.

David A. Savitz, *Childhood Cancer and Electromagnetic Field Exposure*, 178 pp., $45.00.

Richard G. Stevens, *Epidemiological Studies of Cancer and Residential Exposure to Electromagnetic Fields* (50 pp.), and William T. Kaune, *Residential Magnetic and Electric Fields Measured over 24-H Period* (109 pp.), 159 pp., $40.00.

Frank M. Sulzman and David E. Murrish, *Effects of Electromagnetic Fields on Primate Circadian Rhythms*, 65 pp., $16.25.

John R. Thomas and John Schrot, *Investigation of Potential Behavioral Effects of Exposure to 60 Hz Electromagnetic Fields*, 75 pp., $18.75.

Wendell D. Winters, *Biological Functions of Immunologically Reactive Human and Canine Cells Influenced by In Vitro Exposure to 60 Hz Electric and Magnetic Fields*, 105 pp., $26.25.

Jonathan R. Wolpaw, Richard F. Seegal, Robert I. Dowman and Saty Satya-Murti, *Chronic Effects of 60 Hz Electric and Magnetic Fields on Primate Central Nervous System Function*, 165 pp., $41.25.

A complete set of reports costs $419.00. Order from: Charlene McAuliffe, New York State Power Lines Project, Wadsworth Labs, E-297, Empire State Plaza, Albany, NY 12201, (518) 474-7888.

strated by Drs. Abe Liboff and John Thomas (see *MWN*, November 1984).

- Changes in the concentration of neurotransmitter-related metabolites in the cerebrospinal fluid of exposed monkeys, as shown by Drs. Jon Wolpaw and Richard Seegal (see *MWN*, November/December 1985).
- The lack of a positive association between acute non-lymphocytic leukemia and adult exposure to ELF fields at home (see *MWN*, November/December 1986).

Members of the scientific advisory panel who wrote the report were: Drs. Anders Ahlbom (Sweden's National Institute of Environmental Medicine), Ernest Albert (George Washington University Medical Center), Antony Fraser-Smith (Stanford University), Alan Grodzinsky (MIT), Michael Marron (Office of Naval Research), Alice Martin (Northwestern University Medical School), Michael Persinger (Laurentian University), Michael Shelanski (Columbia-Presbyterian Medical Center), Chairman, and Edward Wolpow (Harvard Medical School).

Single copies of the panel's report, *Biological Effects of Power Line Fields*, are available at no charge – while supplies last – from Dr. David Carpenter, School of Public Health Sciences, Wadsworth Labs – E297, Empire State Plaza, Albany, NY 12201, (518) 474-7888. For a list of the individual contractor reports, see the list to the left.

NY State Power Lines Project Summary & Recommendations

SUMMARY

In this section we focus on effects that have been found in the New York-funded projects and which seem worthy of further consideration because of their possible implications for human health.

A. Magnetic Fields

It is clear from the results of the studies sponsored by the Project, as well as from many other recent studies, that both 60 Hz electric and magnetic fields can affect certain biological systems. Magnetic field effects were found in a number of the projects in this program. However, the mechanisms responsible for these effects are unknown. Many effects have been observed at magnetic flux densities in the neighborhood of 100 μT (1 G) or greater. These levels are similar in magnitude to the maximum magnetic flux density directly beneath power transmission lines. Lower magnetic flux density thresholds for most observed field effects have not been determined.

The epidemiological studies raise the possibility that magnetic flux densities one one-thousandth of those shown to have effects in laboratory studies may be a health concern. For several reasons, including the fact that a causal relationship between weak magnetic fields and cancer has not been established and that methodological uncertainties associated with quantifying magnetic field exposure levels exist, we cannot offer a recommendation based on the epidemiological studies. Except for

houses close to power transmission lines, the major sources of magnetic fields in homes are the ground return currents from distribution systems and fields in the immediate proximity of appliances.

B. Neurobiology and Behavior

At the onset of this project there was serious question as to whether there were demonstrable neurobiological or behavioral effects of exposure to electrical and/or magnetic fields. Data accumulated by our contractors as well as a rapidly building literature on retinal magnetoreceptors in birds and mammals leave little doubt that such effects can be observed in well designed experiments.

In contrast, our knowledge of the mechanisms by which these effects are mediated has not advanced significantly. One hypothesis is that several of these effects are mediated via endogenous opioids. However, no data have been obtained to either support or deny this hypothesis. Other effects could be mediated or modulated by changes in the levels or intracellular localization of ionic calcium. The alterations in miniature end plate potential frequency by magnetic fields could be due to small changes in internal ionic calcium. Efflux of calcium from multicellular nervous system preparations reported by other laboratories reflects effects on extracellular calcium, and the physiologic relevance of this calcium store is unknown.

The reliable and specific effects of brief exposures to 60 Hz magnetic fields within a decreased geomagnetic background deserve further attention. Interactions between 60 Hz magnetic fields and the intensity and direction of the static background fields have been suspected by many authors and may be an important source of the variability in occurrence of magnetic field effects. The magnitude of the effect from exposure to the combination of 60 Hz magnetic fields and a reduced geostatic field suggests that geomagnetic fields may interfere with inhibitory behaviors. They would be displayed in situations that required dependence upon subjective estimates of timing and the suppression of impulsive responses.

Our studies have not shown any structural neuropathology in either developing or adult animals. We do not feel that there is a significant risk of structural change at the field intensities normally produced on the ground by power lines.

Accepting that biological effects result from field exposure we are faced with deciding whether these effects might lead to adverse health effects. For most of the findings it must be emphasized that the changes are relatively small. However, some changes, such as the depression of hydroxyindole acetic acid levels in the cerebral spinal fluid seen by Wolpaw and Seegal, are extremely long-lasting. The alterations in circadian rhythms are interesting in that such alterations can be associated with alterations in mood and behavior of subtle types. It is possible that these changes could underlie some of the rather "non-specific" changes which have been reported in the occupational literature on electrical switchyard workers. Certainly, circadian rhythms might be much more suitable parameters to monitor in occupational studies than the more vague subjective responses. A more dramatic effect of fields was the demonstration of a persistent deficit in the response rates of adult rats that had been exposed before and just after birth.

In our studies, no neurobiological effects were seen at field intensities lower than those encountered within the existing right-of-ways of 345 or 765 kV lines. Even those effects encountered were of reasonably small amplitude and could not be said with confidence to indicate health hazards. Our studies are limited in that many of them did not explore weaker magnetic fields or obtain adequate data to determine dose-response characteristics.

C. Cancer

Previous epidemiologic studies on adult and childhood cancer have been questioned because of serious methodological shortcomings. The results of the Savitz study on childhood cancer change the situation considerably because it was designed to minimize flaws in previous studies, and because [the study] was conducted under the supervision of a panel of independent scientists. Even though the Savitz study also has certain limitations, it indicates an excess risk for childhood cancer, in particular leukemias, associated with high current wiring configuration near the homes. Although this study basically confirms the results of the previous studies, the causal relationship is still no more than a hypothesis. However, the basis for this hypothesis is now stronger. The reasons why this is still only a hypothesis are (1) we still only have one well designed study, (2) there are unresolved questions in the Savitz study and (3) there is no basic mechanism known to explain a causal relationship. If future research confirms a causal association between 60 Hz magnetic fields and childhood cancer, public health considerations would have to be developed from (1) baseline risk of childhood cancer, (2) risk increase due to field exposure and (3) distribution of exposure in the population.

On his own initiative, one of the Project investigators undertook studies of the effects of field exposure on the growth of cultured cells in soft agar as measured by the number of clones (colonies) formed. Normal cultured cells do not grow in soft agar unless they are "transformed," and field exposure did not produce transformation. However, the two cancer cell lines tested, which have the inherent ability to grow in soft agar, were reported by the investigator to form more clones after exposure.

Because of the possibility that these results were artifactual, that is, were related not to field exposure but to the inherent variability of the cloning assay, clonogenicity of these same cancer cell lines was examined in a second laboratory. Dr. Hamburger, who participated in the replication study, was the originator of the cloning assay for evaluation of chemotherapeutic agents. In their final report Drs. Hamburger and Cohen report no consistent effects related to field exposure. In the replication study several significant findings are reported but these findings are not reproducibly observed and do not always occur in the same direction, that is in some experiments there are more clones in the control, in other experiments the converse is true.

We conclude that further replications of the influence of fields on the ability of cancer cells to form clones in soft agar are not warranted because: (1) electric and magnetic fields have not been observed to induce transformation in normal cells, (2) exposure of two cancer cell lines in two different laboratories does not provide convincing evidence of an effect of biological significance and (3) extrapolations from the behavior of cancer cells in soft agar to intact organisms cannot be made. Extrapolation of possible field effects on cancer should be done with more relevant assays.

Previous studies were not strongly suggestive of either genetic mutations or chromosomal damage caused by electric or magnetic field exposure. Several independent investigations within the New York State Power Line Projects also failed to find evidence of genetic or chromosomal damage. In light of the epidemiology results future studies on chromosomes should focus on mechanisms of leukemiagenesis, for example oncogenes and promotion. There is currently no convincing evidence for field effects on fertility or growth. Further animal studies would not seem warranted for these variables. Our studies on fetal development have shown no gross morphologic changes. However, the Salzinger results showed persistent changes in

performance of rats that had been exposed *in utero* and immediately after birth. These results may reflect subtle but important alterations of nervous system development that are not reflected in gross morphology.

RECOMMENDATIONS

Research sponsored by this project and related research have demonstrated [a] variety of effects of electrical and magnetic fields. These findings do not readily translate into concrete regulatory recommendations on width of right-of-ways, line heights, or location of lines near homes. They do, however, lead us to the recommendations which follow:

1. There should be a major research effort on means of power delivery and use that would reduce magnetic field exposures.
2. Further study should be made of the interactive effects of the earth's geomagnetic field and 60 Hz fields.
3. The determination of the existence of thresholds for biologic effects of magnetic flux densities should be pursued.
4. The experiments on field effects on learning ability should be replicated.
5. The possible association between cancer (especially leukemias) and magnetic fields must be further investigated. Several avenues of study should be pursued.

a. There should be further epidemiologic study of residential exposure, conducted at more than one site with careful measurement of exposure.
b. Attempts should be made to correlate cytogenetic and diagnostic subgroups of cancers with exposures.
c. Further investigation of occupational exposure and cancer incidence should be conducted with improved documentation of actual exposures.
d. Animal models should be developed and laboratory investigations designed to explore possible mechanisms of field-induced carcinogenesis. If an effect is documented, then the dose-response relationship should be investigated.

6. Further research on the biologic effects of electromagnetic fields is very important. It should be administered by an agency, preferably federal, which is credible by virtue of being clearly independent of partisan influence.

Conference Calendar

New Listings

November 5-7, 1987: **4th Annual Meeting of the American Society of Clinical Hyperthermic Oncology (ASCHO)**, Houston, TX. Contact: Dr. Pierre Greeff, Associate Director, The Stehlin Foundation for Cancer Research, ASCHO, 1315 Calhoun St., Suite 1818, Houston, TX 77002, (713) 659-1336.

November 10-12, 1987: **2nd Annual Society of Broadcast Engineers (SBE) National Convention**, A.J. Cervantes Convention Center, St. Louis, MO. Contact: SBE, PO Box 16861, St. Louis, MO 63105.

January 5-8, 1988: **National Radio Science Meeting**, University of Colorado, Boulder, CO. Contact: Prof. S.W. Maley, Dept. of Electrical Engineering, University of Colorado, Boulder, CO 80309.

January 27-31, 1988: **International Symposium on Work in a Hot Environment and Heat-Related Disorders**, Khartoum, Sudan. Contact: Dr. Moneim Attia, Chief, Occupational Physiologist, Ministry of Health, PO Box 303, Khartoum, Sudan.

April 18-21, 1988: **1988 International Symposium on Radio Propagation (ISRP '88)**, Beijing, China. Contact: Prof. Sha Zong (Z. Sha), China Research Institute of Radiowave Propagation, PO Box 138/88, Xinxiang, Henan, People's Republic of China.

April 19-21, 1988: **International Conference on Lightning and Static Electricity**, Oklahoma City, OK. Contact: Michael Glynn, FAA Technical Support Center, ACT-430, Atlantic City Airport, NJ 08405, (609) 484-4138.

Upcoming Meetings

August 31-September 2: **22nd Annual Microwave Power Symposium: A Macro View of Microwaves and RF Heating**, Hyatt Regency Hotel, Cincinnati, OH. Contact: International Microwave Power Institute (IMPI), 13542 Union Village Circle, Clifton, VA 22024, (703) 830-5588.

September 1-5: **9th International Symposium on Bioelectrochemistry and Bioenergetics**, Szeged, Hungary. This meeting is a Satellite Meeting of the **9th International Union of Pure and Applied Biophysics**, Jerusalem, Israel, August 23-29. Contact: Dr. Lajos Keszthelyi, Institute of Biophysics, Biological Research Center, Hungarian Academy of Sciences, PO Box 521, H-6701, Szeged, Hungary.

September 7-10: **17th European Microwave Conference**, Ergife Palace Hotel, Rome, Italy. Contact: Microwave Exhibitions & Publishers, Ltd., 90 Calverley Rd., Tunbridge Wells, Kent TN1 2UN, U.K.

September 10-11: **International Conference and Workshop on Electromagnetic Interference and Compatibility**, Hotel Taj Residency, Bangalore, India. Contact: Prof. G.R. Nagabhushana, Dept. of High Voltage Engineering, Indian Institute of Science, Bangalore 560 012, India, (812) 364411, ext. 376.

September 17-19: **3rd Annual Clinical Hyperthermia Symposium and Workshop**, St. Louis, MO. Contact: Dr. Bahman Emami, Radiation Oncology Center, Mallinckrodt Institute of Radiology, 4939 Audubon, Suite 5500, St. Louis, MO 63110, (314) 362-8500.

September 28-30: **AC/DC Transmission Interactions and Comparisons Symposium**, Boston, MA. Contact: CIGRE, 112 Boulevard Haussmann, 75008 Paris, France, (1) 45-22-65-12.

September 29-October 1: **9th Annual Electrical Overstress/Electrostatic Discharge Symposium**, The Peabody, Orlando, FL. Contact: Michael Martin, 3M/Static Control Systems, 2111 W. Braker Lane, Bldg.501, PO Box 2963, Austin, TX 78769, (512) 834-3117.

October 11-14: **7th Annual Meeting of the Bioelectrical Repair and Growth Society (BRAGS)**, Holiday Inn Downtown, Toronto, Canada. Contact: BRAGS, PO Box 64, Dresher, PA 19025, (215) 659-5180.

October 14-16: **9th International Colloquium on the Prevention of Occupational Risks due to Electricity**, Hotel Melia Castilla, Madrid, Spain. Contact: Berufsgenossenschaft der Feinmechanik und Elektrotechnik, Gustav-Heinemann-Ufer 130, D-5000 Koln 51, F.R.G., (221) 37781.

October 19-21: **International Radar Conference**, London, U.K. Contact: Conference Services, IEE, Savoy Pl., London WC2R 0BL, U.K., (1) 240-1871, ext. 222.

November 2-5: **DOE/EPRI Review of Research on Biological Effects of 50/60 Hz Electric and Magnetic Fields, Air Ions and Ion Currents**, Hyatt Regency Hotel, Kansas City, MO. Contact: W/L Associates, Suite #4, 120 West Church St., Frederick, MD 21701, (301) 663-1915.