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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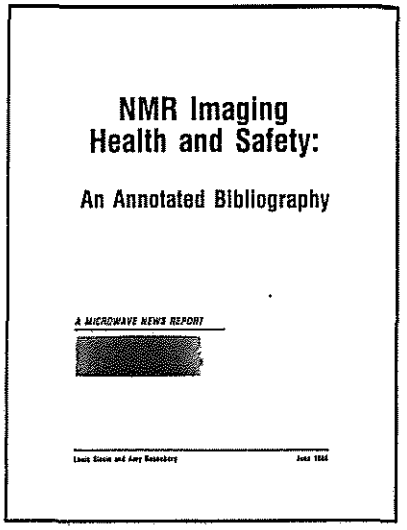
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MICRO WAVE NEWS

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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."

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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.

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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.

MICROWAVE NEWS is published bimonthly • ISSN 0275-6595 • PO Box 1799, Grand Central Station, New York, NY 10163 • (212) 517-2800 • Editor and Publisher: Louis Slesin, Ph.D.; Associate Editor: Maggie Jones; Contributing Editor: Mark A. Pinsky • Subscriptions: $200 per year ($235 Canada & Foreign, U.S. funds only); single copies: $40 • Copyright © 1987 by Louis Slesin • Reproduction in any form is forbidden without written permission. • We invite contributions to *From the Field*, our column featuring news and opinions from the non-ionizing radiation community. Letters from readers are also welcome.

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.

NEW BOOKS

Invited Reviews

Jonathan Black, **Electrical Stimulation: Its Role in Growth, Repair, and Remodeling of the Musculoskeletal System,** New York, NY: Praeger, 1987, 225 pp., $45.00.

There is considerable research activity underway which explores the use of electrical stimulation for a variety of clinical conditions related to repair and growth. Jonathan Black has written a useful and readable book on the subject of electrically stimulated repair, growth, and remodeling of the musculoskeletal system.

He provides an elementary summary of the physics of electric and magnetic phenomena. The presentation is "fiercely" tutorial, seemingly dedicated to the idea that "anyone can learn this stuff." Biologists and others outside the physical sciences should have no difficulty doing just that.

The main focus of Chapter 4 is on electrical phenomena in bone, but other tissues are discussed. Black concludes that the current consensus for strain-related potentials in bone is that streaming potentials are most important in the living animal, with piezoelectric effects playing only a small role, if any.

In Chapter 5, Black discusses the three main approaches to electrical stimulation, which he terms faradic (DC current), capacitive, and inductive. The internal fields and currents characteristically induced by the three approaches are compared. He concludes that the basic mechanism for the effect of stimulation is still unknown and that "...the commonality between the 'electrical' effects produced by these three modalities remains a question of the future."

Chapter 6, entitled "Cell, tissue, and organ culture," reviews the results of experiments on various types of cell cultures. Many useful insights into problems of experimental design are given in the process, and techniques for avoiding artifacts are discussed. One conclusion is that strong evidence for specificity of signal is still lacking. All three stimulation modes have demonstrated some effects in *in vitro* studies, but "...the overall implications of such experiments are unclear."

Chapter 7 reviews the experimental animal studies that have been reported in the literature. Among the soft tissue repair models that have been used with electrical stimulation are cartilage, tendons and ligaments, nerves and surface wounds. Fracture healing, osteoporosis, and graft incorporation are covered in the section on hard tissues. Black concludes that electrical stimulation has elicited a wide variety of mostly nonspecific responses. Modest improvement seems to be possible for some soft tissue injuries. In hard tissues, fracture healing can be accelerated, but the results are less clear for osteoporosis.

Considerable attention is devoted to the clinical definition of "nonunions." As Black points out in Chapter 8, this is not simply a semantic problem, but can have an effect on the outcome of clinical trials. Even given these difficulties, however, it still seems that the three major types of stimulation are about equally effective in healing nonunions. The success rate is apparently between two-thirds and four-fifths. Black points out that various patient factors can reduce the chances of success and suggests that failure to control for or to exclude cases where stimulation is not appropriate could account for some of the variability of results. He concludes that support for clinical applications other than nonunions is still lacking.

The book is an excellent overview of the field and has the necessary background material – a useful glossary of electrical terms and an extensive bibliography of over 400 references – for readers from different scientific disciplines. It has a balanced presentation of the diversity of points of view in the field, and seems successful in distinguishing the results that are reasonably well established from those that are still tentative or speculative.

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Edwin L. Carstensen, **Biological Effects of Transmission Line Fields,** New York, NY: Elsevier, 1987, 397 pp., $58.50.

There is more involved in doing interdisciplinary work than merely learning some facts about the other area. Schoolboys can recite all sorts of things without understanding the underlying theme. This, regrettably, is what I felt while reading Dr. Carstensen's book. It is a collection of facts, some appropriate, some inappropriate – some never mentioned – very often with the wrong ones emphasized.

One must sympathize with the author's plight, since the issues are extraordinarily complex and in transition. Nonetheless, a basic lack of understanding of how science is conducted shines through these pages. The two disciplines that are involved here are not, as the title suggests, engineering and biology, but rather engineering and science. The difficulty in what Dr. Carstensen has attempted is that whereas engineering tends to serve society, science functions in spite of society. Engineering is excellent in applying what is already known to problem solving. In sharp contrast, the business of science deals with that which is *not* already known. Nowhere is this distinction more clearly drawn than in the continuing tension between the "thermal" and "non-thermal" bioelectromagnetic camps. Because the engineering community has a firm grasp of what joule heating is about it has consistently attempted to explain more biological facts than it should using this parameter; when scientists have reported effects at intensities lower than can be explained thermally, these reports have either been discounted as somehow wrong or they have simply been ignored. And so it is in this book, where the reader senses that the author enjoys strong prejudices against those findings that do not conform to conventional engineering wisdom.

Much of the most critically important research efforts – work by the Parkside group, by Reba Goodman, by Bawin and Adey, by Blackman – is summarily dismissed in tables bearing the presumptuous legends "negated" or "unconfirmed." On top of these arbitrary consignments to the dustbin of science, the author steers away from scientific discussion, failing to come to grips with his subject matter in an analytic way, except insofar as it involves parameters with which he is comfortable—pulse shape, frequency, field strength, current. Nowhere, for example, is it mentioned that Goodman has established, using a number of independent assays, that ELF fields cause significant changes

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in mRNA, and that this may be of no little consequence in oncogenesis, or that the experiments by Greenebaum, Goodman and Marron spanned more than 15 years, or that three separate groups – Bawin et al., Blackman et al. and Dutta et al. – have independently reported calcium-efflux effects. Dr. Carstensen deals with this last area in a particularly troubling manner. He implies that all the calcium efflux work is flawed, emphasizing that in some cases the effect is enhanced by fields and in others it is reduced. Because the author decides, *a priori*, that experiments such as these should go only in one direction, he is oblivious to the alternate, more objective conclusion that these experiments are really confirmations of the first, because in all three cases *changes* in efflux were observed following exposures to certain frequencies.

At least one of his comments is flat-out wrong. The report by Takahashi et al. is not "essentially negative," as he writes, but the direct opposite: they measured a consistent, significant variation in ELF-related DNA synthesis. Perhaps what the author means is that he can't understand why such effects diminish at higher fields. Indeed, the concept of an amplitude window creates great difficulties for Dr. Carstensen throughout the book. For example, there is an interesting passage on p.158: after remarking on a "few unconfirmed claims" that ELF magnetic fields at 0.1 to 0.2 μT may increase the "rate of cancer" while much greater fields do not, he writes that "failure of biological effects to be dependent on the magnitude of exposure is one of the traits which characterize 'pathological' science." This is not the first time that this pejorative expression has been used to characterize observations that do not fit neatly into a third-year engineering text. Everyone's interests would be better served if authors were more circumspect in dealing with work they consider outlandish. After all, there are many ways to do bad science. It is difficult to decide which is worse—those who cut corners in their haste to claim new effects or those whose science is suspect because of their servile attitudes towards benefactors in industry or the military.

In defense of this book, it certainly is easier to be critical in hindsight. It is unfortunate that it was assembled during the very time that a number of new developments were becoming more distinct, especially the Savitz study, but also some of the newer models that appear promising in terms of interaction mechanisms. One hopes that as the scientific community continues to cement the experimental and theoretical evidence for low-level bioelectromagnetic effects, the engineering community will correspondingly mute its overreaction.

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Sisir K. Dutta and Richard M. Millis, editors, **Biological Effects of Electropollution: Brain Tumors and Experimental Models,** Philadelphia, PA: Information Ventures, Inc., 1986, 245 pp., $45.00.

This book is a collection of 18 papers presented at a symposium at Howard University in September 1985, with the addition of "An Overview of the Electropollution Literature" consisting of more than 150 abstracts dealing with 13 different aspects of the problem culled from the BENER Digest.

As the subtitle suggests, there is a moderate emphasis placed upon brain tumors (and nerve cells) and model systems with which to attack the problem. However, the content of the individual papers presents a little of something for everyone. The first paper, by Elder, is a brief but excellent summary of the issues related to promulgation of exposure standards for RF. Gandhi's paper discusses such proposed standards from the point of view of his own research on induction of RF currents. Brain tumors are discussed by Lin and by Spitz and Johnson, all three of whom present the same data as in their journal publications. The paper by Blackman is particularly interesting and possibly of considerable importance. He presents data indicating that the intensity and direction of the local geomagnetic field interact with the intensity and frequency of the experimental field (either direct ELF or ELF-modulated RF) in a fashion consistent with a magnetic resonance phenomenon. This observation may lead to a useful concept of mechanism of action — something that has been lacking so far. Other papers deal with microwave effects upon behavior, calcium flux across cell membranes, neurotransmitters and proposed model systems for experimentation. Gordon presents a reasoned approach to the problems of relating animal experimentation to humans and Parshad reports a new observation that pulsed microwaves at low SARs kill neuroblastoma cells in culture.

The section of abstracts from the literature represents a fair cross section of the available data; however, in several of the sections it seems that more significant citations could have been used. For the experienced worker in the field the book does not represent anything particularly new and it is not complete enough to constitute a good survey. It is, however, a very useful introduction to this controversial field for the scientist who is interested but not yet knowledgeable. It should be in all engineering libraries and would make a useful addition to medical school libraries as well.

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Charles Polk and Elliot Postow, **CRC Handbook of Biological Effects of Electromagnetic Fields,** Boca Raton, FL: CRC Press, Inc., 1986, 503 pp., $165.00.

The appearance of this handbook signals a significant new step in the maturation of bioelectromagnetics, a discipline which covers an exceptionally broad range of topics. When considering a handbook, one looks for authority, accuracy, completeness and conciseness, while hoping that the treatment of developing areas won't too soon be out of date. Although I have some grave regrets, the book is a success.

Many of the 11 chapters are authoritative, including several that are the most elegant treatments I know. C. Polk's introduction to the physical principles which underlie electromagnetic interactions with biological systems gets the book off smartly. K. Foster and H. Schwan follow with a highly readable article on dielectric theory and dielectric measurements of biological materials. High marks also go to M. Stuchly and S. Stuchly for a review of theory, technique and apparatus in radio-frequency dosimetry, and to R. Frankel for a comprehensive overview of biological magnetism from its historical roots to the recent work on the wondrous perfect little magnets synthesized within some cells.

Thermoregulation (E. Adair) and the techniques of RF tis-

sue dosimetry (J. Lin) are also treated with distinction. Chapters like these serve well the purpose of a handbook: to provide an intuitive understanding of essential relationships, a few fundamental equations, and those essential derived results we want to have at hand.

Most of the reviews of biological studies do less well, in some places failing to present a cohesive portrait of the research, in others being dated, and in still others omitting important information. Faced with a vast number of topics and reports, various styles emerge, ranging from "encyclopedic" to "tabular with comments." On the plus side, the final chapter on "Modulated Fields and 'Window' Effects," by E. Postow and M. Swicord makes an insistent effort to illuminate fundamental mechanisms, and provides the greater measure of the scientific "jousting" to be found in the entire book. In contrast, M. Miller's out-of-date review of ELF bioeffects mostly honors worn shibboleths. And nowhere in the book is it emphasized that membrane events are the central feature of a host of biological and biochemical responses to low-level electromagnetic fields.

The attempt to treat electromagnetic exposure standards in a few lengthy tables found in an appendix is inadequate and introduces inaccuracies. In recognition of the importance of such public issues, several authors discuss the epidemiologic and experimental evidence for an association of cancer with exposure to electromagnetic fields, but none of the treatments in this fast-moving area is satisfactory or up-to-date.

A glance at the excellent index shows that engineering and biophysical topics are covered with completeness, while the scope of biological topics is more limited. I was also disappointed because there is little sense of excitement or of the flow of developments and scientific ideas in the pioneering work now going on in bioelectromagnetics. Despite its inordinately high price, the handbook should find its way to many desks where it will prove a trusted companion as well as a continuing source of stimulation and provocation.

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Briefly Noted

Theodore Bullock and Walter Heiligenberg, editors, **Electroreception,** New York, NY: Wiley, 1986, 722 pp., $99.95.

In his review (*Nature*, May 7, 1987), Professor James Gould of Princeton University called this collection of papers "a well-organized, systematic explication of what is known about electroreception in fish."

William E. Burrows, **Deep Black: Space Espionage and National Security,** New York, NY: Random House, Inc., 1986, 401 pp., $19.95.

The U.S. will have spent close to $50 billion for "technical intelligence collection" in the 1980s, according to Burrows – almost twice the cost of landing men on the moon. Yet most of the programs which generate communication, photographic or signal data are top secret, or in Washington jargon, "black." Burrows raises the cloak of secrecy and provides a detailed look at the space-based systems that have become an integral part of our defense establishment.

H. Keith Florig, **Population Exposure to Power-Frequency Fields: Concepts, Components and Control,** Ann Arbor, MI: Dissertation Information Service, University Microfilms, Inc., 1986, 265 pp.

For his doctoral thesis at Carnegie-Mellon University, Florig investigated people's exposures to ELF electric fields, primarily power lines and electric blankets, and the shielding from external sources provided by houses. He concludes with a discussion of regulatory strategies in the absence of firm bioeffects data.

Barton C. Hacker, **The Dragon's Tail: Radiation Safety in the Manhattan Project, 1942-1946,** Berkeley, CA: University of California Press, 1987, 258 pp.

Hacker summarizes the work of doctors and scientists dealing with the known and unknown dangers of nuclear energy in the era of the Manhattan Project. Their work in the development of regulations to protect against ionizing radiation is covered in detail.

Bernhard Keiser, **Principles of Electromagnetic Compatibility, 3rd Edition,** Norwood, MA: Artech House, Inc., 1987, 383 pp., $60.00.

Keiser has been teaching a short course on EMC for the practicing engineer at George Washington University for more than ten years. This volume is essentially the course notes, covering all the basics from grounding, bonding and shielding to FCC, VDE, CISPR and military standards.

Richard L. Miller, **Under the Cloud: The Decades of Nuclear Testing,** New York, NY: The Free Press, 1986, 547 pp., $24.95.

Miller has written an extraordinarily detailed history of the U.S. nuclear testing program. He traces the movement of the radioactive clouds that crossed the country between 1951 and 1962, sprinkling fallout on American cities.

Wilbert F. Snyder and Charles L. Bragaw, **Achievement in Radio: Seventy Years of Radio Science, Technology, Standards and Measurement at the National Bureau of Standards,** Washington, DC: US Government Printing Office, 1986, 842 pp., $55.00; Order No.003-003-02762-6.

This large book recounts the history of NBS's accomplishments in radio science from its first measurements in 1911, ten years after Marconi successfully transmitted a message across the Atlantic Ocean, to today's concerns over electromagnetic interference. The authors – each worked for the bureau for more than 40 years – cover a lot of ground, from ELF to millimeter waves. The volume is well illustrated, with copious footnotes and references.

UPDATES

BIOLOGICAL EFFECTS

EEPA Review... The Electromagnetic Energy Policy Alliance (EEPA), an industry group based in Washington, DC, has released a *Biostatistical Review of Selected Literature on the Biological Effects of Radiofrequency Electromagnetic (RFEM) Energy*, an 89-page critical analysis of 32 published studies. The reviews were written for EEPA by Dr. Murray Selwyn of Statistics Unlimited, Inc. (a consulting firm in Auburndale, MA), Dr. Jennifer Anderson of Boston University and Dr. Constantine Maletskos, a consultant long associated with the NCRP. The 32 papers, which were selected by EEPA, cover a mix of different types of effects at various frequencies from ELF to MWs and come from around the world, including the U.S.S.R., Poland and Spain. According to Selwyn, the "overall statistical quality of [the] papers was low," but he also pointed out that they were "about typical" of papers in other fields. The report concludes that "the set of studies reviewed provides no conclusive evidence of harmful effects, except for laboratory studies where RFEM radiation produced substantial heating." Copies are available for $195.00 each from Richard Ekfelt, EEPA, 1255 23rd St., NW, Washington, DC 20037, (202) 452-1070.

EMP

Protecting Medical Devices... The U.S. Army is continuing research on ways of protecting medical devices against EMP (see *MWN*, January/February 1986). The Army has awarded IRT Corp. of Vienna, VA, $469,000 to develop specifications for hardening medical equipment and methods for verifying its immunity. One specific system which the Army wants to protect from EMP radiation is the MEDEX Military X-Ray system.

Is 50 kV/m the Right Threshold?... The maximum ground-level electric field from a nuclear EMP is 50 kV/m, according to most unclassified sources. Indeed, EMP simulators like EMPRESS II are designed to test electronics up to that threat level. But will this level provide adequate protection from a high-altitude nuclear attack? Maybe not, according to Rudy Garbely of ITT-Cannon. Writing in the May issue of *Defense Electronics*, Garbely warns that, "It has been impossible to verify this number [50 kV/m] with real-world testing." He also points out that, "Anyone touching a path to electrical ground at the moment of the blast could be burned or even electrocuted."

GOVERNMENT

NIEHS Stops In-House Research... The National Institute of Environmental Health Sciences (NIEHS) has closed down its in-house research effort on non-ionizing radiation bioeffects – following the example set by the EPA. Dr. Don McRee, who headed the program and is now a grant reviewer, told *Microwave News* that NIEHS stopped supporting the program "due to its loss of priority" at the agency. NIEHS is still funding extramural research, however; at present, Drs. Ernest Albert, Om Gandhi, Eugene Goodman, Bill Guy and Sol Michaelson have grants.

U.S.-U.S.S.R. Cooperation Continues...NIEHS's McRee is also the coordinator of the U.S.-U.S.S.R. joint project on non-ionizing radiation bioeffects. The project's next meeting, which will include a review of the last two years of research and planning for the next two years, is scheduled for the week of October 18 in Research Triangle Park, NC. Professor Mikhael Shandala of the A.N. Marzeev Institute of General and Communal Hygiene in Kiev will lead the Soviet delegation – three associates from the Kiev institute and Dr. T. Kalada of the Institute of Occupational Safety and Health and Dr. N. Vasilevsky of the Institute of Medicine, both in Leningrad. The October workshop will be open to the public. Those interested in attending should contact McRee at NIEHS, PO Box 12233, Research Triangle Park, NC 27709, (919) 541-1442.

MEASUREMENT

VDT Fields... Due to the increasing concern over adverse effects of VDT fields, the EMC Society of the IEEE has set up a working group (No.1140) to develop a standard for electric and magnetic near-field measurements in the 1 kHz to 1 MHz frequency range. H. Stephen Berger of The Electro-Mechanics Co. in Austin, TX, and Jim Greeson of IBM in Research Triangle Park, NC, are co-chairing the working group, which is planning to have its first meeting on August 25 in Atlanta, GA, during the IEEE EMC Society's annual symposium. For more information, contact Berger at Electro-Mechanics, PO Box 1546, Austin, TX 78758, (512) 835-4684.

MEETINGS

EMP Bioeffects... The Boeing Corp. hosted a two-day meeting, *Joint Government/Industry Conference on Biological Effects of Occupational Exposure to Electromagnetic Pulses (EMP)*, June 17-18 in Seattle, WA. The conference, which was attended primarily by DOD staffers and defense contractors, was organized to see if there were any health problems among those working with EMPs, according to Bill Morgan, the chief of radiation health protection at Boeing. No problems were reported, he said in a telephone interview, and now Boeing is considering relaxing its exposure standard of 50 kV/m

to match the 100 kV/m level adopted by the U.S. Air Force and under consideration by the American Conference of Government Industrial Hygienists (ACGIH). "We're still on the fence," Morgan replied when asked whether Boeing will follow suit. The company has an ongoing epidemiological study of EMP health risks, but the number of workers exposed is too small to get reliable data: "It will take another 330 years to have enough numbers to make the study significant," Morgan said.

NAB & RF Compliance... The National Association of Broadcasters (NAB) will feature a seminar on *RF Radiation Regulation Compliance* on September 12 at its *Radio '87* conference in Anaheim, CA. Among the panelists will be Dr. Bob Cleveland of the FCC, John F.X. Browne, who runs his own consulting firm, Dane Ericksen of Hammett & Edison and Ken Keane of Wilner & Scheiner. For more information, contact: NAB, 1771 N St., NW, Washington, DC 20036, (202) 429-5300.

OVENS

Leaks Increase with Age... Old microwave ovens leak more than new ones, according to a radiation survey by Dr. Timothy Miller of the Fermi National Accelerator Laboratory (Fermilab) in Batavia, IL. Measurements of 80 ovens between 1974 and 1985 revealed that the greatest leakage was usually at the top and right edges of the door seal. Only five of 425 readings met or exceeded the FDA's 5 mW/cm² emission standard; all five ovens were built by the same manufacturer. Miller, the group leader for environment and safety at Fermilab, told *Microwave News* that the five ovens were made by Litton; these were older units with an average age of 6.6 years. The mean leakage level was 0.2 ± 3.1 mW/cm². In a paper in the *American Industrial Hygiene Association Journal (48*, pp.77-80, January 1987), Miller noted that this leakage level is "considerably less than [those in previous studies] and may be the result of improved oven design." He concluded that the optimum frequency for surveying oven leaks is once a year. In a telephone interview Miller said that this year's survey showed no leakage above the FDA standard.

POWER LINES

The Regulatory Dilemma... The research group at Carnegie-Mellon University in Pittsburgh, PA, led by Dr. M. Granger Morgan, reviews the problems of trying to regulate risks under uncertainty in an article on "Power-Frequency Fields" appearing in the Summer 1987 *Issues in Science and Technology*, which is published by the National Academy of Sciences.

STANDARDS

Portland Vote Near... After years of debate about an RF/MW exposure standard, the Portland (OR) City Council is set to vote on a proposed ordinance on August 12. The present favored option is a level that is one-fifth of the ANSI standard, or 200 μW/cm² between 30 and 300 MHz. Originally the city's Bureau of Planning had proposed a 100 μW/cm² standard, but there was greater support for the higher limit (see *MWN*, September/October and November/December 1985). An amendment lowering the proposed limit back to the 100 μW/cm² level has been introduced and will also be considered on August 12. At its July 22 meeting, the council adopted a resolution asking for a study of the merits of registering and monitoring sources of RF/MW radiation but, according to Steven Gerber of the city's Bureau of Planning, "the funding for the study is not yet in hand." Gerber added that a "quick and dirty" estimate of the economic impact of various RF/MW standards indicated that a 200 μW/cm² rule would have no impact on Portland broadcasters, but that a level of 125 μW/cm² would probably require the installation of some new antennas and the movement of others. At 100 μW/cm², there would be "definite" effects and at 75 μW/cm², "substantial" changes would be necessary, he said.

Ovens in Belgium... The Belgian government has proposed a microwave oven emission standard that is essentially the same as that set by the American FDA: 1 mW/cm² for new ovens and 5 mW/cm² for those already in use. Comments are due on August 25; the standard is scheduled for adoption on January 25, 1988. A copy of the proposal, which is in French and in Dutch, is available from the National Bureau of Standards' Office of Product Standards Policy, Adm. Bldg. A629, Gaithersburg, MD 20899, (301) 975-4037. Ask for TBT/87.58.

ETC...

Noise on Demand... It's touted as "The Ultimate Device for the Communications Age." It's "Hang-Up Helper," which can imitate the scratchy noise of phone line static: "When hopelessly trapped in an unwanted telephone conversation, simply hold 2-3 sheets of Hang-Up Helper next to the mouthpiece. Crinkle it between your fingers to create the static-like noise and tell the person, 'There's trouble on my line. I'll have to call you back.' Then hang up." Developed by the owners of an advertising agency, Hang-Up Helper has a suggested retail price of $4.95. For your own box of the 3-inch-square foil sheets which "get you off the hook," contact: Hang-Up Helper, PO Box 5474, Austin, TX 78763.

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MICRO WAVE NEWS

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New Listings

Occupational EMF Exposure Again Linked to Brain Cancer

A new epidemiological study has once again documented an increased risk of malignant brain tumors among workers exposed to electromagnetic fields (EMFs). Dr. Marjorie Speers and co-workers found that the brain cancer risk grew linearly with the probability of EMF exposure on the job. Most dramatically, Speers found that the risk for utilities workers was *13 times* the expected rate for unexposed workers.

"The literature is building in this area," Speers told *Microwave News*. "These studies point to a link between EMFs and brain cancer." Speers, who was formerly at the Department of Preventive Medicine and Community Health at the University of Texas Medical Branch in Galveston, is currently at the Centers for Disease Control in Atlanta, GA.

Speers's findings, reported in the June 1988 issue of the *American Journal of Industrial Medicine*, support those of Dr. Samuel Milham, Jr. of the Washington State Department of Social and Health Services in Olympia (see *MWN*, J/A82 & M/A86), and of Dr. Ruey Lin, formerly with the Maryland Department of Health and Mental Hygiene and now at the National Taiwan University in Taipei (see *MWN*, O84 & J/A85). Neither Milham nor Lin were able to rule out the possible contribution of toxic chemicals, however.

(continued on p.15)

EMP Technician with Leukemia Files Suit Against Boeing

On June 10, a Seattle, WA, electronics technician diagnosed with leukemia filed a class action suit against Boeing and several other companies, claiming that his condition is a result of exposure to electromagnetic pulse (EMP) radiation. He is also seeking an injunction on behalf of approximately 600 other Boeing workers to stop their exposure to EMP without their knowledge or consent.

Robert Strom, who was employed by Boeing for 27 years, worked with EMP from 1983 through 1985, testing its effects on electrical and electronics equipment as part of the MX "Peacekeeper" missile program. In 1985, he was diagnosed with leukemia.

According to Strom's complaint, which was filed in the Superior Court of Washington for King County, Boeing and co-defendants Boeing Medical Services, Lovelace Biomedical and Environmental Research Institute and EG&G Co. had long known of the health dangers associated with exposure to EMP, yet they never warned workers or took any precautions to safeguard them.

(continued on p.14)

HIGHLIGHTS

BEMS Briefs

This year's Bioelectromagnetics Society (BEMS) meeting* may be remembered more for extending earlier studies than for opening new frontiers. But as one researcher put it at the close of the conference, "The easy part is identifying the effects; now we have to dig in and explain what's going on. Some effects may not pass muster, but others will yield insights into mechanisms."

What follows are some highlights of what was said during the sessions and in the halls during the breaks.

* * * * * *

The blood-brain barrier (BBB) controversy is on again. Despite reports to the contrary, microwaves do seem to increase the leakage of certain chemicals through the BBB.

At BEMS, a team headed by Dr. David Lange of the Johns Hopkins University (JHU) Medical School in Baltimore, MD, reported that 2.45 GHz radiation at specific absorption rates (SARs) of 2 W/Kg—both continuous wave (CW) and pulsed microwaves (MWs)—could "significantly alter BBB function in the absence of hyperthermia." Lange told *Microwave News* that 2 W/Kg appears to be the threshold for CW radiation, but it is still too early to say anything definite about pulsed radiation.

Could the observed effect have been caused by an increase in blood flow, as has been alleged by some critics? "We anticipated that argument," Lange said, "and our system eliminates that possibility."

In their much-discussed commentary in *Nature* arguing for guidelines for halting MW-related risk research (see *MWN*, J/F88), Drs. Ken Foster and Bill Pickard cite MW-induced BBB permeability as an example of an effect that turned out to be an artifact after an "extensive" follow-up.

When asked for his reaction to the new work, Pickard said: "This is an interesting report. If validated by a number of additional groups, then it would be reasonable to reopen the question." (Foster did not attend the BEMS meeting.)

Many experts already believe that the MW-BBB link deserves more scrutiny. The well-documented work by Henry Kues of the JHU's Applied Physics Lab and by Jack Monahan of the Food and Drug Administration (FDA), showing extensive leakage through the blood-eye barrier following MW exposure, pointed to the need for a fresh look at the BBB studies. In fact, Kues is a member of Lange's study team.

In his presentation, Kues said that he and Monahan were "zeroing in" on a mechanism: "It may be thermal but not in the way that most people think of thermal effects."

The JHU-FDA results could be the basis for the next generation of safety standards. They undermine the 4 W/Kg threshold for adverse effects used by the American National Standards Institute (ANSI) and the National Council on Radiation Protection and Measurements (NCRP); but they provide support for the 1 and 2 W/Kg thresholds advocated by the Environmental Protection Agency and by the National Institute of Occupational Safety and Health (NIOSH), respectively.

The JHU-FDA data present a challenge for those writing health standards: How to deal with the MW/drug synergy problem? Kues and Monahan have shown that the permeability of the blood-eye barrier is ten times lower—0.26 W/Kg—when the eye is pretreated with glaucoma medicine, e.g., timolol maleate, before MW exposure. This is not an insignificant consideration given that, according to FDA estimates, over two million Americans use these drugs on a regular basis.

* * * * * *

There were rumors at BEMS that the long-delayed and nearly-forgotten NIOSH criteria document on RF/MW radiation may actually emerge from its bureaucratic limbo in the fall—nearly a decade after the first draft was released. Similar rumors have been heard in past years, so a wait-and-see attitude is in order.

* * * * * *

Nature has published a letter critical of the Foster-Pickard commentary by Dr. Ross Adey of the VA Hospital in Loma Linda, CA. Writing in the June 2 issue, Adey charges that Foster and Pickard "ignore a wealth of findings" on recent bioelectromagnetic research.

* * * * * *

The reopening of the BBB debate comes as a number of researchers are beginning to doubt that aqueous solutions of DNA can absorb 1-10 GHz MWs. In our last report, British and Swedish researchers had just published a paper in *Nature* stating that they could not observe the resonances, and Dr. Ken Foster was about to publish a similar report in the *Biophysical Journal* (see *MWN*, J/A87).

At BEMS, Dr. Chris Davis of the University of Maryland, in whose lab then-doctoral student Dr. Glenn Edwards first discovered this DNA phenomenon, said that he too was now unable to find the resonance and was giving up the search.

Davis used a new, improved experimental system and followed the same protocol as in the earlier studies. He said that he is not convinced that Edwards was wrong because he could not even coax the system to show an artifactual resonance. At this point, Davis said, "I am not sure what is going on."

For his part, Dr. Ted Grant of Kings College, London, U.K., who was the senior author of last year's *Nature* paper, has moved on to other research problems. "We saw no scientific reason for continuing the work on DNA absorption," he told *Microwave News* after the meeting. Grant and co-worker Dr. Camelia Gabriel are now turning their attention to the interaction of plasmid DNA with low frequencies—from a few Hz to 10 MHz.

Of course, the last word must come from Edwards himself. He was not at BEMS and was away from his office at Vander-

**10th Annual Meeting of the Bioelectromagnetics Society*, June 19-23, Stamford, CT.

bilt University in Nashville, TN.

* * * * * *

There was a standing room only audience for the presentation of the "Henhouse Project" results (see *MWN*, M/A88 & M/J88), and a throng always surrounded the two Henhouse poster papers.

Thanks to support from the Office of Naval Research, the proposition that weak pulsed magnetic fields (PMFs) can have serious biological effects has come a long way since Spain's Dr. Jocelyne Leal first published her landmark findings in 1982. Nevertheless, there were many skeptical looks in the room. Some people are still not ready to believe that a 1 μT (10 mG) peak PMF—the average field is 0.05 μT (0.5 mG)—may be hazardous.

Interestingly, these values are of the same order of magnitude as the hypothesized threshold of 2-3 mG for power line magnetic fields. It is especially noteworthy in the context that PMFs have been shown to be as much as ten times more active than an equivalent unmodulated field.

That the debate will continue is clear from the recent publication of a paper by a team at the University of Rochester reporting an inability to repeat the Leal chick egg findings (*Journal of Anatomy, 157*, pp.101-104, 1988). The Rochester research, which was supported by a consortium of New York State utilities, was designed to "minimize differences" with the Spanish experiments.

Leal is not so sure. She told *Microwave News* that there were some important differences between the two protocols. The extent of the difference is uncertain because a number of details are missing from the Rochester paper, but one major change is that the Rochester group used a PMF with a 42 μsec rise time, while the Henhouse labs used a 2 μsec rise time. "They do not appear to have seen the correction to our early papers," she said. Leal originally reported that two of the experimental PMFs had rise times of 42 μsec, but later issued a correction noting that 2-7 μsec was more accurate (see *MWN*, D84).

* * * * * *

Dr. Reba Goodman of Columbia University, who, with Dr. Ann Henderson of Hunter College, has already shown that RNA transcription is extraordinarily sensitive to specific EM signals, reported that these same signals can turn on or enhance the expression of specific oncogenes—sequences of DNA which, on activation, can trigger the development of cancer. Indeed, the oncogenes are themselves sensitive to small changes in frequency and pulse modulation.

In a paper that was just published in the *Proceedings of the National Academy of Sciences* (*85*, pp.3928-3932, June 1988), Goodman and Henderson show that 60 Hz and 72 Hz sine waves induced surprisingly different protein profiles. For instance, a class of proteins was synthesized with the 72 Hz sine wave signal that was absent from the 60 Hz sample. "Changes in protein synthesis are a natural outcome once you have altered RNA transcription. Now, our lab will turn to identifying and quantifying the specific proteins associated with specific oncogenes," Goodman said.

Dr. Jerry Phillips of the Cancer Therapy and Research Center in San Antonio, TX, is pursuing a similar line of research, investigating the *ras, fos, myb* and *myc* oncogenes with a different cell line. Similarly, a group at the Battelle Pacific Northwest Labs in Richland, WA, should soon be reporting results on its oncogene studies.

* * * * * *

The meeting provided another boost for the fortunes of the cyclotron resonance (CR) model developed by Drs. Abe Liboff of Oakland University and Bruce McLeod of Montana State University. Dr. Judy Reese of the Battelle Pacific Northwest Labs announced that she had observed the same 16 Hz field effect in diatoms as was first reported by Liboff, McLeod and the University of Kentucky's Steve Smith (*Journal of Bioelectricity, 6*, pp.1-12 and pp.153-168, 1987 and *Bioelectromagnetics, 8*, pp.215-227, 1987).

In Smith's experiment, the earth's ambient field was adjusted so that the CR frequency of calcium ions was 16 Hz—selected to coincide with the Adey-Blackman frequency window. Smith found a sharp increase in diatom motility at 16 Hz, with a static magnetic field of 209 milligauss. Now, so has Reese.

"I have seen the same effect, but I have not replicated the experiment," Reese told *Microwave News*, explaining that she had not tested the adjacent frequencies and could not consider her experiment a replication until the whole resonance curve has been retraced. She will soon run the experiment at 14 and 18 Hz. A number of variables—including quality of light and the age of the culture—affect the experimental outcome, she said.

Liboff is understandably delighted by the news. Even without the full resonance curve, he sees it as a confirmation of the theory. "It marks a critical turning point in the general acceptance of the CR hypothesis," he said. He would now like to see Battelle expose whole animals to CR conditions.

* * * * * *

One of the most interesting new developments came from Battelle's Dr. Fred Leung. He reported what may be the first evidence of a marker for electric field-induced stress: Rats exposed to relatively high E-fields show a brown, sticky material at the edges of their ears. The effect, which he noticed by serendipity in the course of another study, became apparent for rats exposed to 10 kV/m, though it was only statistically significant at the next level of exposure, 65 kV/m.

Chemical analysis of the brownish substance indicates that it is made up of red porphyrins which, Leung said, are known to be related to stress reactions. While many have long alleged that electromagnetic fields can cause stress, Leung may now have found a useful indicator to pinpoint and characterize the reaction. He is planning follow-up experiments.

USAF Weighs Moving PAVE PAWS Radar To Counter In-Flight Explosion Hazard

The U.S. Air Force (USAF) is considering relocating its PAVE PAWS radar at Robins Air Force Base (AFB), GA, to reduce the danger of explosions on aircraft flying through the radar's main beam. The rough cost of moving the PAVE PAWS system to a new site within a 200-mile radius is $37.7 million, according to a new study prepared by Raytheon Co. for the Electronic Systems Division at Hanscom AFB, MA.

"The high energy contained in PAVE PAWS pulses may pose a hazard to electro-explosive devices (EEDs) carried on military and commercial aircraft," Raytheon warns. EEDs are used as detonators for munitions, among other applications.

Relocation of the radar is "only one of the alternatives still under consideration," a USAF spokesman told *Microwave News*, but added that "it wouldn't make sense economically." The USAF is "waiting for the user—the U.S. Space Command—to come back with answers and ideas before the final decision is made," he said.

Captain Dan Curtis, an electronics engineer who worked on aircraft avionics and electronic warfare (EW) systems in the USAF for 22 years, told *Microwave News* that the PAVE PAWS radar is at the end of one of the runways at Robins AFB: "It should absolutely not have been put there," he said. Since he retired from the USAF in 1979, Curtis has managed EW programs for a number of defense contractors and is now a freelance consultant.

The USAF is also planning to upgrade the PAVE PAWS radar by a factor of ten (10 dB). Raytheon estimates that the combined cost of moving and upgrading the Robins radar is $119.7 million, excluding government and other contingency costs.

If the USAF decides to move the radar, there will be a gap in radar coverage for the Southwest region. Raytheon predicts that the Robins PAVE PAWS site will have to be completely abandoned early in the relocation program, but the new site will not go on-line for more than three years.

The "safe" exposure limit for in-flight aircraft carrying EEDs is 10 mW/cm^2, according to Raytheon, creating an air space "hazard zone" of one nautical mile for the current system and three nautical miles after the 10 dB upgrade.

In its final report, *PAVE PAWS EED Hazard Study*, Raytheon proposes to use an "embedded tracker" (ET)—based on subarrays within each of the present PAVE PAWS arrays—to monitor air traffic approaching the hazard zone and to order an automatic shutdown of the radar. This and other short-term modifications would "establish a significant measure of hazard reduction through pulse energy reduction...and [through] blanking radar beams coincident with aircraft in the hazard zone."

Raytheon concludes that the ET plan is the "safest and most economical approach to solving the EED problem." The company, which is based in Wayland, MA, estimates that, under worst case conditions, the ET would fail to identify a plane in the hazard zone only once every 12 years for the current configuration and once every 1.6 years for the 10 dB system. In addition, airplanes approaching the PAVE PAWS from the rear, as well as slow-moving helicopters, would continue to be at risk.

A spokeswoman for Raytheon had no comment on the report, saying that all the pertinent information had been sent to the USAF and that the company no longer had copies of the report. The USAF would only release portions of the report to *Microwave News* because certain sections were classified.

In a telephone interview, Ramie Thompson of the Franklin Research Center in Norristown, PA, said that the vulnerability of EEDs to accidental initiation by radiofrequency (RF) radiation depends on a number of variables, including the type of EED and the type of RF signal. Thompson, who has worked on this problem for 30 years, said that a film made at Franklin 25 years ago shows EEDs being triggered by a 1200 MHz perimeter radar at a distance of more than 700 feet.

"There have been a number of unexplained incidents that could have been caused by EEDs initiated by RF radiation," Thompson said.

A lawsuit, now pending in federal court, seeks greater protection against the accidental initiation of EEDs (see *MWN*, S/O87)—a problem called Hazards of Electromagnetic Radiation to Ordnance (HERO). Patricia Axelrod, the coordinator of Project HERO, based in Washington, DC, said that she is preparing to file a motion for summary judgment in her case.

"Based on my experience with weapon systems, both conventional and nuclear, it is my opinion that the PAVE PAWS radar at Robins AFB should discontinue operation until the existing electromagnetic radiation hazard is resolved," Robert Aldridge, a former weapons designer for Lockheed Missiles and Space Co. in Sunnyvale, CA, wrote in a statement for Project HERO's lawsuit. Aldridge is now a freelance consultant based in Santa Clara, CA.

PAVE PAWS radars are designed to detect sea-launched ballistic missiles. There are now four PAVE PAWS radars operating in the U.S.: at Otis AFB, MA; at Beale AFB, CA; at Goodfellow AFB, TX; and at Robins. They operate at 420-450 MHz, have a detection range of 3,000 nautical miles and are said to be capable of detecting an object the size of a basketball at a range of more than 1,200 miles, according to the 1988 *C^{3}I Handbook*.

The Robins Air Logistics Center at Robins AFB provides worldwide logistics management for the F-15 and many other aircraft, as well as for air-to-air, air-to-ground and ground-to-ground missiles.

RF Heating of the Wrist and Ankle

Relatively low levels of 1-50 MHz radiofrequency (RF) radiation can cause "substantial" heating of human wrists and ankles, according to the latest results from Dr. Om Gandhi's lab at the University of Utah in Salt Lake City.

In a series of studies over the last four years, Gandhi has shown that radiation levels permitted under the 1982 American National Standards Institute (ANSI) guidelines can induce surprisingly large specific absorption rates (SARs) —up to 1,045 W/Kg in the wrist when in contact with a car (see *MWN*, J/A85 & J/A86). The ANSI limits are based on an SAR of 0.4 W/Kg and 8 W/Kg for whole-body and partial-body exposures, respectively.

Writing in the June 1988 *IEEE Transactions on Biomedical Engineering*, Gandhi and Jin-Yuan Chen warn that the temperature increases they measured among healthy human subjects were on the surfaces of the ankles and wrists and that the "internal tissue temperatures may be still higher." And, in a strong challenge to the adequacy of the 1982 ANSI standard, Gandhi and Chen say that the new results lead them "to question the safety of the so-called safety guideline."

Gandhi recently became the co-chairman of subcommittee C95.IV, which is in the process of revising the 1982 ANSI limits (see *MWN*, M/A88).

Chen and Gandhi found that RF-induced currents can cause maximum changes in surface temperature of [0.0045 x SAR] and [0.0048 x SAR] degrees Centigrade per minute for the ankle and wrist, respectively (where "SAR" is in W/Kg).

J. Patrick Reilly of the Johns Hopkins University Applied Physics Lab (APL) in Laurel, MD, has been developing models of the interaction of electrical currents with nerve cells. A well-illustrated paper describing this work appears in the *Johns Hopkins APL Technical Digest, 9*, pp.44-59, 1988.

Communications Roundup

Seattle, WA, To Set RF/MW Standard

On August 8, the City of Seattle proposed a 100 $\mu W/cm^2$ standard for exposures to radiofrequency and microwave (RF/MW) radiation in the 30-300 MHz frequency band. The standard, if adopted, would be twice as strict as the one set by the National Council on Radiation Protection and Measurements (NCRP) and ten times as stringent as the one recommended by the American National Standards Institute (ANSI). It would be the toughest standard in the country, apart from New York City's informal 50 $\mu W/cm^2$ limit.

The proposed rules will allow for special exemptions if the 100 $\mu W/cm^2$ standard causes a hardship. Clifford Marks, a senior environmental planner with Seattle's Office of Long-Range Planning, explained that a 200 $\mu W/cm^2$ limit could be applied to certain sources if the owners could show that the relaxation would not cause an unacceptable health risk to susceptible populations, e.g., the ill and the elderly. Marks expects that broadcasters can meet the 100 $\mu W/cm^2$ limit, though he predicted that they would contest the rule to prevent it from becoming a precedent for future standards.

City officials were not persuaded by the NCRP's rationale for using a safety factor of five to convert the ANSI occupational limits to a general population standard, according to Marks. A factor of ten is more common, he said, pointing out that the scientific basis for both the 100 $\mu W/cm^2$ and the 200 $\mu W/cm^2$ standard is a bit soft and that the city government "wanted to take a strong stand."

Under the rules, which could be in place by next spring, all major sources of RF/MW radiation, especially radio and television antennas, would have to get a permit.

Last December, the city issued its *Environmental Study of Telecommunications Facilities in Seattle*, which is the basis for the proposed rules. The study includes an analysis of selected bioeffects studies by Drs. Don Justesen of the VA Hospital in Kansas City, MO, and Henry Lai of the University of Washington in Seattle. Extrapolating from their report, the Seattle study finds that the question is "whether the *in vivo* and *in vitro* experimental findings are supportive of a hypothesized connection between RF irradiation and malignant disease. The answer is a highly qualified yes."

This view, together with other biological effects studies and a desire to take a conservative approach to public health, contributed to the city's staff decision to set a conservative standard, Marks said.

One of the proposed sites for new broadcast antennas is the Columbia Center, the tallest building in downtown Seattle. However, as Jim Hatfield of Hatfield & Dawson, a consulting firm in Seattle, told *Microwave News*, "The potential for human exposure from broadcast radiation is greatest at the Columbia Center." According to a worst case analysis, the power density on the roof of the Columbia Center would be 900-3,000 $\mu W/cm^2$. (Hatfield worked on the Seattle study.)

King County, in which Seattle is located, has been developing its own RF/MW radiation standard for many years, but the process is now bogged down in quasi-legal proceedings.

For more information, contact: Clifford Marks, Office of Long-Range Planning, City of Seattle, 200 Municipal Building, Seattle, WA 98104, (206) 684-8056.

Hawaii Highway and Omega VLF Station

The long-running fight over the building of the H-3 highway under the Kaneohe OMEGA antenna on the island of Oahu in Hawaii has flared up again with the release of a Coast Guard study which warns of serious health risks to construction workers and the public (see *MWN*, J/A82 & N/D86).

The study by Paul Gailey of the EC Corp. in Oak Ridge, TN, concludes: "It is clear...that field strengths on the highway surface will exceed occupational standards and present unacceptable exposures to the public." It also states: "Failure to anticipate and mitigate shock hazards could result in serious injuries or death to construction workers."

The analysis of the risks associated with the H-3 highway appear in an appendix to Gailey's report, *Modeling and Measurement of Electromagnetic Fields near LORAN-C and OMEGA Stations*. According to the Coast Guard, the study was "initiated to determine whether or not there are any adverse effects on Coast Guard personnel working in and around the facilities."

The OMEGA system operates at 10.2-13.6 kHz. The Kaneohe station has an output of 10 kW.

Gailey himself suffered "numerous shocks" in the course of his measurements: "The shocks occurred through clothing when brushing against a conductive surface and were startling and painful. More severe shocks will be experienced if grounded workers contact insulated vehicles," he wrote.

In a telephone interview with *Microwave News*, Gailey said that the hot and humid climate on Oahu will aggravate the problem. "The fields are high—400-500 V/m on the ground and 1,000 V/m further up," he warned, "I would not be surprised if some workers suffer serious shocks—and some of these could be above the let-go threshold." He stressed that his estimates were based on a worst case analysis and that they do not include the use of mitigation techniques. As Gailey pointed out in his report, these problems are not "insurmountable."

State Transportation Director Ed Hirata told the Honolulu *Star-Bulletin & Advertiser* (July 17) that the Coast Guard report has no "credibility" and that the planning and construction of the highway will continue.

MWN References

Beginning with this issue, we will abbreviate references to past issues of *Microwave News*. In the past, we have spelled out the months and listed the entire year. In our new format, July/August 1988 will appear as J/A88. Prior to July/August 1985, *Microwave News* was on a monthly schedule. To avoid confusion March and May 1985 will appear as Mr85 and My85, respectively.

For more information, contact: K.F. Doolan, Safety Programs Division, U.S. Coast Guard, Washington, DC 20593.

EPA To Measure RF in McFarland, CA

Staffers from the Environmental Protection Agency's (EPA) Office of Radiation Programs will go to McFarland, CA, in the fall to measure RF radiation levels from the Voice of America transmitter in Delano.

In a May 23 letter, EPA Administrator Lee Thomas pledged to assist California health officials in finding the cause of the cancer cluster among the children of McFarland (see *MWN*, J/F88): "I share the public's concern about the suggested link between electromagnetic fields and human cancer....I believe that our involvement in your investigation of the McFarland situation may produce information valuable to our understanding of the relationship between environmental electromagnetic fields and carcinogenesis."

In April, Dr. Kenneth Kizer, the director of California's Department of Health Services, asked for EPA's technical assistance. Kizer had requested that EPA start taking measurements by the end of the month, but Thomas said that "prior commitments" would force a delay until late summer or early fall.

Meanwhile, the plight of McFarland's children took on new stature as the Rev. Jesse Jackson referred to the cluster in his nationally televised speech at the Democratic National Convention on July 19.

FCC Revises NEPA Rules

On July 11, the Federal Communications Commission (FCC) released final rules to ensure that satellite transmitters aboard ships do not cause overexposure to RF radiation. The commission's action is a further refinement to its regulations for implementing the National Environmental Policy Act (NEPA), which can require the preparation of environmental impact statements (see *MWN*, A85).

At the same time, the FCC decided it could not justify similar rules for ship radar stations because there is a "lack of evidence for potential harm."

After the FCC first proposed the rules (see *MWN*, M/A87), the EPA had argued that the commission's approach was "too passive to be effective." The FCC responded that it believes that its RF rules have resulted in "widespread compliance" among the broadcasters already covered.

With this action, the commission has decided to close the docket (No.79-144) on its NEPA rules. "The basic rules have now been established," FCC's Dr. Bob Cleveland told *Microwave News*. Nevertheless, a number of related items are still pending before the commission: a method for dealing with FM boosters (see *MWN*, J/F88); a petition filed by the National Association of Broadcasters for preemption of state and local RF standards (see *MWN*, M/J86); and a petition from Hammett & Edison for clarification of when environmental assessments are required (see *MWN*, S/O87).

The FCC notes that there is a likelihood of new developments—both in basic research and in new health standards—and that it therefore may "revisit this matter in other proceedings."

EPA-FCC RF Survey in Spokane, WA

The EPA–FCC survey of RF radiation—primarily from AM radio transmitters—in Spokane, WA, has been released. In general, the field levels were far below the 1982 American National Standards Institute (ANSI) guidelines, though the report acknowledges that "levels far below the ANSI guide can cause annoying RF shock/burns."

At the front of a school close to KGA, a 50 kW AM station, the team found fields of 13.9 V/m and 39.7 mA/m. Inside the room closest to the transmitter, the electric field measured 28 V/m, with higher levels (92-190 V/m) near fluorescent lights. The magnetic fields in that room were generally less than 50 mA/m, but larger fields (470 mA/m) were identified near metal fixtures and ground wires.

After the school was built, complaints about RF burns and shocks led to the installation of a metal roof to limit the electric fields inside the classrooms.

KGA has also been at the center of a lawsuit: in 1986, Thomas DiLuzio alleged that long-term exposure to AM radiation from the station caused his wife to develop a terminal case of multiple myeloma, a cancerous proliferation of blood plasma cells that is similar to leukemia (see *MWN*, S/O86). Robert Greer of the Spokane law firm of Feltman, Gebhardt, Eymann & Jones, which is representing DiLuzio, said that the case is still pending.

A copy of *Radiofrequency Electromagnetic Fields and Induced Currents in the Spokane, Washington Area, June 29-July 3, 1987* (EPA/520/6-88/008, June 1988) is available from: Ed Mantiply, Office of Radiation Programs, EPA, PO Box 98517, Las Vegas, NV 89193, (702) 798-2440.

Navy Selects Ocean Site for EMPRESS II

Following years of controversy, the U.S. Navy is using its second Electromagnetic Pulse Radiation Simulator for Ships (EMPRESS II) in the Atlantic Ocean instead of the Chesapeake Bay (see *MWN*, 084, N84, J/F87, M/A87 & M/J88). Testing began in early June.

The EMP simulator is operating in international waters in the Virginia Capes (VACAPES) Operating Area, approximately 15 miles offshore from Currituck Light, NC. In a statement published in the June 1 *Federal Register* (53 *FR* 20083), the Navy stated that neither the VACAPES area nor the Chesapeake site would cause an adverse environmental impact. The ocean site was selected because it "can be utilized to test deep draft ships which do not have unrestricted access to the Chesapeake Bay" and because it "presents minimal conflict with other users in the area."

EMPRESS II will be in operation during the months of June through August. When in use, the Navy will enforce an exclusion zone with a radius of two miles, from the ocean surface to an altitude of 6,000 feet.

With respect to the EMPRESS I facility at the Solomons Annex of the Patuxent River Naval Air Station, MD, the Navy scheduled a public meeting for August 9 to review its environmental assessment of the simulator's continued operation. For more information on the meeting, contact: Diane Palermo, Code C12, Naval Surface Warfare Center, White Oak Lab, Silver Spring, MD 20903, (301) 394-2865.

CONFERENCES

New Listings

1988

October 5-7: **IEEE International Carnahan Conference on Security Technology**, Lexington, KY. Contact: Louise McGill, Conference Secretary, IEEE International Carnahan Conference, PO Box 23961, Lexington, KY 40523, (606) 223-8580.

October 6-7: **International Conference on Microwavable Foods**, The Swiss Grand Hotel, Chicago, IL. Contact: Robin Geary, Conference Manager, Schotland Business Research, Inc., Princeton Corporate Center, 3 Independence Way, Princeton, NJ 08540, (609) 520-0100.

1989

January 29-February 3: **Winter Meeting of the IEEE Power Engineering Society**, Penta Hotel, New York, NY. Contact: IEEE Society Special Services, 345 East 47th St., New York, NY 10017, (212) 705-7895.

March 19-23: **37th Annual Meeting of the Radiation Research Society (RRS)**, Westin Hotel, Seattle, WA. Contact: RRS, 1101 Market St., Philadelphia, PA 19107.

March 27-30: **INTERMAG '89 Conference**, Mayflower Hotel, Washington, DC. Contact: Diane Suiters, INTERMAG '89, 655 15th St. NW, Suite 300, Washington, DC 20005, (202) 639-5088.

March 29-30: **IEEE AESS National Radar Conference**, Sheraton Park Central Hotel, Dallas, TX. Contact: IEEE AESS Radar Conference, Attn: Russell Logan, PO Box 1000-262, McKinney, TX 75069.

April 4-7: **6th International Conference on Antennas and Propagation**, University of Warwick, U.K. Contact: Institution of Electrical Engineers, Savoy Place, London WC2R 0BL, U.K., (01) 240-1871, ext. 222.

April 24-28: **International Conference on Radar**, Versailles, France. Contact: International Conference on Radar, 11 rue Hamelin, F-75783 Paris Cedex 16, France, (1) 45 05 71 69.

ELF NEWS

« Power Line Talk »

Participants at the May 1988 International Agency for Research on Cancer (IARC) **meeting on ELF fields and cancer**—most of whom are planning or are now engaged in epidemiological studies—agreed to standardize study designs to aid the comparison of results (see *MWN*, M/A88). In this way, IARC's Dr. **Michel Coleman** told *Microwave News*, it should be easier to reach a consensus on the health risk. Specifically, there was general agreement on malignancies to be studied (leukemia and brain tumors); on how they will be defined (histology and International Classification of Diseases–Oncology); and on confounding variables (ionizing radiation and toxic chemicals). Progress was also made on standardizing exposure assessment, though this was more difficult in the absence of a well-defined mechanism of action. A summary report on the meeting has been submitted for publication.

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The International Radiation Protection Association's International Non-Ionizing Radiation Committee (**IRPA/INIRC**) is revising downward its **guidelines** for public and occupational exposures to power line **electric and magnetic fields**. In May 1987, the committee issued a draft proposal which specified permissible exposures of less than 5 kV/m and 2 G (200 μT) for the public and 10 kV/m and 50 G (5 mT) for workers—for both groups, higher values would have been allowed for short periods of time (see *MWN*, M/A88). Australia's Dr. **Michael Repacholi**, the new chairman of IRPA/INIRC, says that a final draft should be completed by the end of September. When asked what the new values would be, he said that he would prefer to wait until the draft was finalized before citing any specific numbers.

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After 39 years with GE, Dr. **Don Deno** has retired to concentrate full time on his business, **Electric Field Measurement Co.**, based in West Stockbridge, MA. He said that he is planning to introduce a number of "exciting new products" in the fall. Deno is facing increasing competition. In our last issue, we mentioned the new meter being marketed by **Integrity Electronics & Research Co.** of Buffalo, NY. Now **Holaday Industries,** which already has a major share of the meter market at RF/MW frequencies, has a new survey meter for power line fields. The HI-3600-02 can measure both electric and magnetic fields: 1 V/m–200 kV/m for electric fields and 0.01 mG–2 G for magnetic fields. The unit costs $995. You can also buy the 50/60 Hz sensor separately ($475) and use it with Holaday's VDT survey meter. (Contact: Holaday Industries, Inc., 14825 Martin Dr., Eden Prairie, MN 55344, (612) 934-4920.)

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Florida watchers: The earliest that power line **siting rules** could be in place is January 1, according to Buck Oven of the state's Department of Environmental Regulation (DER), and he is quick to add that the date is "very optimistic." The 500 kV Lake Tarpon–Kathleen transmission line has been approved by the state siting board—made up of the governor and his cabinet. The latest draft of the state power line rules, dated July 6, cites specific EMF limits for that line: 1.56 kV/m and 160 mG. Oven explained that the magnetic field value applies for maximum loading conditions, which can occur only 15 hours a year. Otherwise, the magnetic field will be 37 mG at the edge of a 100-foot right-of-way. As the rule development process continues, applications for new lines continue to be received by the DER, Oven said.

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The new popular interest in power line safety in the U.K.—in large part prompted by a BBC documentary—has led the **Central Electricity Generating Board** (CEGB) to issue pamphlets on the health effects of EMFs. In one of these ***Power Points,*** the CEGB comments: "All available worldwide evidence has been reviewed by a number of national and international bodies, including the World Health Organization, and the Industrial Advisory Council...in Britain. Their unanimous conclusion is that no risk to public or occupational health has been demonstrated."

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Australia's 220 kV line between Brunswick and Richmond has not been canceled as we reported in our March/April issue (see also *MWN*, J/A86), according to Peter Wallace of the **State Electricity Commission of Victoria** (SECV). Instead, a review panel, chaired by David Scott, Victoria's Environment Commissioner, has been set up to consider the proposed line as well as other options. Scott was also a Community Commissioner of the SECV, but he has stepped down until the review is completed. Construction of the transmission line is on hold until the panel issues its report. The panel will make sure that interested groups have the resources to participate. One such association, **Powerline Action,** an umbrella organization of community groups and residents based in Melbourne, plan to monitor the work of the panel. Meanwhile, the new analysis by Dr. Nancy Wertheimer and Ed Leeper of Dr. Richard Stevens's epidemiological data has been picked up in the Australian press. It was the lead article in the June 27 issue of *Electricity Week*, a publication based in Sydney, and was featured in a number of newspapers.

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It's official—Drs. **Richard Stevens** and **David Savitz's epidemiological studies** are in print: *American Journal of Epidemiology, 128*, pp.10-20 and 21-38, respectively. The New York State Power Lines Project (NYPLP) has issued a supple-

ment to Savitz's original report which presents some additional methodological details not contained in the published paper; these include analyses of traffic density and wire coding. This new Savitz report, which includes a copy of the published paper, is available for $22.50 from: Charlene McAuliffe, NYPLP, School of Public Health, Corning Tower, Room 2517, Empire State Plaza, Albany, NY 12237. Allow 2-4 weeks for delivery and make checks payable to *Health Research Inc.*

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EPRI has again expanded its staff working on power line health research. Dr. **Leeka Kheifets** has joined the institute's radiation studies program, where she will oversee epidemiological studies on both power line EMFs and ionizing radiation.

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From 1987 to 1993, Canada's **Ontario Hydro** will contribute $4.5 million (Canadian) to a $7.1 million program assessing the risks associated with EMFs. Speaking at the Bioelectromagnetics Society meeting in June, Hydro's Murray Walsh said that the utility is negotiating with the Royal Society of Canada to act as the Scientific Review Committee "to establish credibility for the program." Of the $7.1 million, $2.8 million has been allocated to occupational epidemiology and $1.3 million to animal carcinogenesis. Ontario Hydro's position is that biological responses to EMFs have been identified, but that no human health risk has yet been established, Walsh said. Consequently, there have been no changes in operating or design practices.

Correction on New Zealand Cancer Study

Dr. Neil Pearce has issued a correction to his 1985 survey of leukemia in New Zealand electrical workers (see *MWN*, My85). Pearce now reports that the odds ratios for "radio/television repair" workers and for "electricians" are 8.17 and 4.75 respectively—both are statistically significant. He notes, however, that the causes of the increased risks "remain unclear."

Pearce, who is at the Department of Community Health at the Wellington School of Medicine in Wellington, New Zealand, previously had reported an odds ratio of 8.17 for "electronic equipment assemblers," but this was actually the odds ratio for radio/television repairmen. The assemblers, in fact, did not have an elevated incidence of leukemia. The "electricians" category was omitted in the 1985 table.

Pearce's correction appears in the July 2 issue of *The Lancet* (p.48). The original survey was published in the April 6, 1985 issue of *The Lancet* (pp.811-812).

Sleeping with EMFs

Electric Blankets Shift Menstrual Cycles

Sleeping with an electric blanket may affect menstrual cycles in women, according to the interim results of a new study by Dr. Bary Wilson of Battelle Pacific Northwest Labs in Richland, WA. Wilson believes that this previously undetected effect may be mediated by the pineal gland.

The study, which he presented in June at the *Annual Meeting of the Bioelectromagnetics Society* in Stamford, CT, revealed "dramatic" changes in the cycles of those using AC-powered electric blankets.

"It's an observation at this point," Wilson told *Microwave News*, "but if confirmed, this will be the first indication that the mechanisms for pineal effects in animals may also be at work in humans."

Earlier Battelle studies have shown a link between electric field exposures and changes in pineal rhythms in rats (see *MWN*, M/J88). Melatonin, which is produced and secreted by the pineal gland, plays a key role in hormonal cycles associated with menstruation and reproduction in women.

Wilson collected urine samples from 33 women three times a week and tested them for a melatonin metabolite. In addition, a clinical psychologist monitored and assessed the participants' general mood. The results of the melatonin experiments are still incomplete; only 40% of the data had been analyzed by the time of the presentation. No statistically significant changes in mood and affect were observed. Wilson plans to follow up the study with detailed analyses of the menstrual cycle changes. The work is being sponsored by the Electric Power Research Institute (EPRI).

CA Study Finds No Leukemia Risk

There is no increased risk of myelogenous leukemia among adults who use electric blankets in Los Angeles county, according to a new study by a research group at the Department of Preventive Medicine at the University of Southern California School of Medicine in Los Angeles.

The study, which was published in the most recent issue of *Bioelectromagnetics* (*9*, pp.207-213, 1988), estimates that general electric blanket use increases overall electric and magnetic field exposures by 36% and 82%, respectively. Typical field strengths were 40 V/m and 24 mG.

Dr. John Peters and co-workers suggest that the hypothetical link between electric blanket use and leukemia should now be tested in an area "with a harsher climate."

The work was supported by grants from the American Cancer Society and the National Cancer Institute.

EMF Exposure and Control

• EPRI is funding a pilot study on the prevalence of electric blanket use among a group of 4,000 pregnant women. The objective of the study is to determine the feasibility of study-

ing the growth and development of children exposed to electromagnetic fields (EMFs) *in utero*. The eight-month effort, which is in progress, is headed by Dr. Michael Bracken of the Department of Epidemiology and Public Health at the Yale School of Medicine in New Haven, CT. EPRI is providing $80,000 for the project, which is part of a larger study on the effects of tobacco smoke supported by the National Institutes of Health.

• In a technical report directed at waterbed heater manufacturers, Ed Leeper outlines some cost-efficient methods for minimizing the generation of magnetic fields. The report, *Possible Inexpensive Modifications of Waterbed Heaters to Reduce AC Magnetic Field Production*, argues that magnetic fields can be easily reduced—by 95% or more. For a copy of the report, contact: Ed Leeper, Salina Star Route, Boulder, CO 80302, (303) 442-3773.

TX Supreme Court Refuses To Review Klein Decision

On July 6, the Texas Supreme Court refused the Klein Independent School District's request for a review of the state court of appeals' decision to overturn a $25 million judgment against Houston Lighting & Power (HL&P).

The Klein–HL&P suit, arguably the most famous power line case ever litigated, was filed after HL&P built a 345 kV transmission line across school property without obtaining proper permission. A jury ordered HL&P to pay Klein $25 million in punitive damages and to either move the line or pay tens of millions of dollars to move nearby school buildings (see *MWN*, N/D85). The utility subsequently moved the line at a cost of $8.6 million and appealed the damage award. Last year, the court of appeals struck down the $25 million award (see *MWN*, N/D87), and Klein in turn appealed the reversal.

According to Harris Leven, an HL&P attorney, the utility's liability is limited to the value of the easement while its power line was on Klein property—$104,000 plus interest, as determined by the original trial court.

On July 21, Dixon Montague of the Houston law firm of Vinson & Elkins filed a new motion with the state supreme court for a rehearing. "It's not over yet," he told *Microwave News*. He said that the issue of punitive damages "should be addressed, and it is distressing that [the judges] do not want to." He acknowledged that if the court refuses, the case would be over.

Montague said that the supreme court is now on its summer break and the earliest his motion could be considered is in mid-September.

Eastern European Literature on ELF Bioeffects

Identifying and locating papers from Eastern European countries on the biological effects of electromagnetic fields has always been difficult and time consuming. Now, the Canadian Centre for Occupational Health and Safety (CCOHS) has made it easier with a comprehensive bibliography—*Biological and Health Effects of Extremely Low Frequency (ELF) Fields: A List of Eastern European Literature.*

The 43-page guide, which features hundreds of references, was assembled by the center's Andrew Cutz and Dr. Karel Marha. Most of the citations are to papers from the 1970s and 1980s—a few date to the 1950s and 1960s.

Copies are available for $10.00 from: Chief Accountant, CCOHS, 250 Main Street East, Hamilton, Ontario L8N 1H6, Canada. Only prepaid orders will be accepted. Make checks payable to the *Receiver General for Canada* and cite order No.B88-1E.

NY Power Authority Prepares for $60 Million Trial

In preparation for the $60 million Marcy–South suit beginning September 8 (see *MWN*, M/A87 & M/J88), the New York Power Authority (NYPA) on June 1 filed testimony with the New York State Court of Claims from seven scientists on the health effects of electromagnetic fields (EMFs). These experts, who are unanimous in their finding of no significant effect, have not previously done research on the biological effects of EMFs.

• Dr. Stuart Aaronson, chief of the laboratory of cellular and molecular biology at the National Cancer Institute (NCI) in Bethesda, MD, reports that "there is no scientific basis for concluding that [EMFs] induce any consistent effects on cell growth properties...associated with the acquisition of malignant properties."

• Dr. Richard Bockman, a researcher and attending physician at the Memorial Sloan–Kettering Cancer Center in New York City, states that "no endocrine or metabolic disorders can be demonstrated in animals or humans exposed to EMFs at the levels generated by electric power lines."

• Dr. Roswell Boutwell, a professor in the Department of Oncology at the University of Wisconsin in Madison, concludes that "there is no scientific basis for the assertion that power frequency EMFs are either cancer initiators or promoters."

• Dr. E.A. Egan, a professor of pediatrics and physiology at the University at Buffalo, NY, "conclude[s] with confidence that EMFs associated with electric power generation, transmission and use have had no ill effects on reproduction or prenatal development."

• Dr. Lucius Sinks, a specialist on pediatric cancer at the NCI, reports that "after consideration of genetics, hematology, immunology and epidemiology taken as a whole, it is my opinion that there is no causal relationship between exposure to power frequency EMFs and childhood cancer."

• Dr. H.S. Terrace, a professor at Columbia University in New York City, concludes that "the hundreds of studies...on the behavioral properties of EMFs...have failed to uncover any persuasive evidence that such fields have any psychological significance."

• Dr. Margaret Tucker, an epidemiologist at the NCI, sums up recent research as having yielded "no persuasive scientific evidence of increased risk of cancer in children or adults from exposure to power frequency EMFs."

The Washington, DC, law firm of Crowell & Moring worked with the NYPA in assembling the expert testimony.

For more information, contact: Kathleen Ryan, NYPA, 10 Columbus Circle, New York, NY 10019, (212) 397-7410.

NEW BOOKS

Selected Reviews

Martin Blank and Eugene Findl, editors, **Mechanistic Approaches to Interactions of Electric and Electromagnetic Fields with Living Systems**, New York, NY: Plenum Press, 1987, 444 pp., $85.00.

Papers on mechanisms can be tough to get through. If you have had trouble, this collection makes the task easier. Blank and Findl gave the contributors enough space to put their ideas into a larger context, allowing them to connect ideas from a number of different studies and thereby helping the reader to get a better understanding of what they are proposing. All the major theories that seek to explain EMF interactions are here—from A(dey) to Z(on). This text is a welcome addition to the literature.

Jonathan M. Charry and Robert I. Kavet, editors, **Air Ions: Physical and Biological Aspects,** Boca Raton, FL: CRC Press, Inc., 1987, 240 pp., $132.00.

According to one contributor to this review, after decades of studies on whether air ions—for instance from DC power lines—have any health effects, the controversy "is as lively today as it was 20, 30 or 40 years ago." Nevertheless, at the end of his own 50-page chapter, replete with detailed tables, Charry concludes that, while ions can have biological and behavioral effects, they "are for the most part small in absolute magnitude" and "are for the most part transient." The nine chapters in this volume, most of which were written with the support of the EPRI and the DOE, have a huge number of references—one suspects every paper ever written on air ions is included. Unfortunately, two different footnoting systems are used, often making it difficult to find the desired citation.

Andrew A. Marino, editor, **Modern Bioelectricity,** New York, NY: Marcel Dekker, Inc., 1988, 1,136 pp., $149.75 (U.S. and Canada).

Marino has assembled a most useful collection of papers by some of the leading members of the international research community. Of special note are the contributions by Szmigielski (Poland), Shandala (U.S.S.R.) and Smith (U.K.). Szmigielski's chapter is the first published report of his epidemiological studies documenting an increase in cancer among members of the Polish military exposed to RF/MW radiation (see *MWN*, Mr85 & J/F87). Information on Soviet power line health research is very rare, making Shandala's contribution all the more welcome. And Smith's experiments on EMF effects under conditions of nuclear magnetic resonance (NMR) prompted a lot of interest when they were first published in 1983, and the new details presented here are the first to emerge since then (see *MWN*, O83). In his introductory overview, Becker writes that, "Bioelectricity...provides us with a totally new scientific paradigm by which to understand the basic physiological mechanisms occurring within living organisms...." The 27 papers written for this book go a long way toward elucidating that paradigm.

Sol M. Michaelson and James C. Lin, **Biological Effects and Health Implications of Radiofrequency Radiation,** New York, NY: Plenum Press, 1987, 675 pp., $79.50.

This book is testimony to the fact that the thermalists have not given up. As the authors conclude: "Most of the experimental data support the concept that the effects of microwave exposure are primarily, if not wholly, a response to hyperthermia or altered thermal gradients in the body." But this view is at the cost of passing over or ignoring the key experiments that now dominate the field. Guy's $5 million long-term exposure study is not mentioned, nor are Szmigielski's papers on co-carcinogenicity of MWs with benzopyrene. In fact, the whole cancer issue is dismissed in one short paragraph. The permeability of the blood-brain barrier is assumed to be due to increased blood flow (see p.2 of this issue), and Thomas's landmark MW-Librium synergy paper gets only one sentence. Kues's studies on the eye and Gandhi's work on low-frequency shocks and burns are not cited. Even the chapter on standards is clearly out of date: The 1986 NCRP report is ignored—the only post-1980 references made are to IRPA (1981) and ANSI (1982).

Mary Ellen O'Connor and Richard H. Lovely, editors, **Electromagnetic Fields and Neurobehavioral Function,** New York, NY: Alan R. Liss, Inc., 1987, 416 pp., $74.00 (***Progress in Clinical and Biological Research,*** Volume 257).

Each paper in this collection, which grew out of a meeting held in Corsendonk, Belgium, in the summer of 1984, received two independent reviews. Both ELF and RF/MW frequencies are covered by experts specializing in thermal and non-thermal effects. For instance, Lotz and Saxton report on their experiments indicating that the thermoregulatory response of Rhesus monkeys exposed to 225 MHz radiation cannot fully redistribute the heat load, even in a cool environment. And on the other hand, Adey and Blackman each put forward a multi-step mechanism to explain their well-known calcium efflux results. Also of special interest are the papers by Albert, Monahan, O'Connor, Semm and Shandala.

Michael I. Sobel, **Light,** Chicago, IL: The University of Chicago Press, 1987, 263 pp., $29.95.

Sobel, a professor of physics at Brooklyn College in New York City, has written a highly informative yet readable account of everything related to light. His elegant explanations of blackbody radiation, mirages, holograms, microscopes, black holes—to cite only a few examples—are science writing at its best. Even if you know why the sky is blue or why there is a flash of green at sunset, you will learn something new. Don't pass up this book.

NEW BOOKS

U.S. Department of Defense, **Soviet Military Power: An Assessment of the Threat 1988,** Washington, DC: U.S. Government Printing Office, 1988, 175 pp., $10.00 (Stock No.: 008-000-0488-9).
Tom Gervash, **Soviet Military Power*: *The Pentagon's Propaganda Document, Annotated and Corrected,** New York, NY: Vintage Books, 1987, 159 pp., $14.95.

Every year since 1981, the DOD has issued its assessment of the Soviet military. This year's report, like past ones, gives the Pentagon's view of the Soviet's RF/MW weapons program: "A ground-based [RF weapon] could be tested in the 1990s," and "Recent Soviet developments in the generation of [RF] energy could lead to fundamentally new types of weapon systems that could jam or destroy electronics equipment or be used in antipersonnel roles." Gervash, a freelance editor and writer, has issued a "corrected" version of the 1987 DOD report. He has reproduced the report in a reduced format and corrected every statement he believes is inaccurate. With respect to RF weapons, he writes: "Our research...started way before theirs and has progressed far beyond theirs. Little of promise has emerged." There is also a lot about Soviet radars in each of these volumes.

Recently Published

E.G. Bowen, **Radar Days,** Philadelphia, PA: Taylor & Francis, 1987, 231 pp., $28.00.

Jeremy Campbell, **Winston Churchill's Nap: A Wide-Awake Inquiry into the Human Nature of Time,** New York, NY: Touchstone Books (Simon & Schuster), 1988, 432 pp., $8.95.

Victor L. Granatstein and Igor Alexeff, editors, **High-Power Microwave Sources,** Norwood, MA: Artech House, 1987, 500 pp., $77.00.

A.P. Sakis Meliopoulos, **Power System Grounding and Transients,** New York, NY: Marcel Dekker, Inc., 1988, 472 pp., $99.75 (U.S. and Canada).

National Research Council, **Health Risks of Radon and Other Internally Deposited Alpha-Emitters (BEIR IV),** Washington, DC: National Academy Press, 1988, 602 pp., $32.50 (paperbound), $42.50 (clothbound).

Philippe Robert, **Electrical and Magnetic Properties of Materials,** Norwood, MA: Artech House Books, 1988, 475 pp., $72.00.

Merrill Skolnik, **Radar Applications,** New York, NY: IEEE Press, 1988, 488 pp., $53.95 ($40.50 for IEEE members).

Fleur L. Strand, editor, **Fourth Colloquium in Biological Sciences, Blood-Brain Transfer,** New York, NY: The New York Academy of Sciences, 1988, 325 pp., Volume 529.

Forthcoming

Bertil R.R. Persson and Freddy Stahlberg, **Health and Safety of Clinical NMR Examinations,** Boca Raton, FL: CRC Press, Inc., November 1988, 208 pp., $99.50.

UPDATES

BIOLOGICAL EFFECTS

Reviews of EMF Effects... Dr. Harry Brown and Swaraj Chattopadhyay of Rutgers University in New Brunswick, NJ, have written a comprehensive review article, "Electromagnetic-Field Exposure and Cancer," which appears in the May 1988 issue of *Cancer Biochemistry Biophysics* (*9*, pp.295-342). The review covers frequencies from ELF up to RF/MW and includes over 300 references. They conclude: "Animal carcinogenesis studies and human epidemiological data indicate that exposure to non-ionizing radiation can play a role in cancer causation." Brown does fundamental research in enzyme catalysis at the university's Department of Biochemistry. "A Review of Epidemiological Studies of the Health Effects of Living Near or Working with Electricity Generation and Transmission Equipment," by Dr. Michel Coleman of the International Agency for Research on Cancer in Lyon, France and Dr. Valerie Beral of the London School of Hygiene and Tropical Medicine in the U.K., appears in the *International Journal of Epidemiology* (*17*, pp.1-13, 1988). Though they cover a number of different types of health risks, their principal focus is on cancer and leukemia. Drs. Timothy Aldrich and Clay Easterly of the Oak Ridge National Lab in Tennessee also survey the ELF literature in "Electromagnetic Fields and Public Health," which is in *Environmental Health Perspectives*, *75*, pp.159-171, 1987. Their review has 133 references.

More on MW Accidents... In their January 15 letter to the *Journal of the American Medical Association (JAMA)*, Drs. Mauricio Castillo and Robert Quencer describe the case of an F-16 pilot accidentally exposed to MW radiation with resulting short-term memory loss (see *MWN*, J/F88). Their letter prompted responses (June 3 issue of *JAMA*) from Dr. Samuel Forman and Dr. Milton Zaret, who have both previously written on MW effects. Forman, based in Cincinnati, OH, writes that he too has seen victims of MW exposure—with headaches, insomnia, photophobia and hypertension, attributable to post-traumatic stress disorder (see *MWN*, D84). Dr. Milton Zaret, an ophthalmologist based in Scarsdale, NY, well known for his work on the ocular effects of MW radiation, notes that chronic exposure to non-ionizing radiation can also cause reactions that appear only after a time delay. He proposes that the unexplained increase in breast cancer-related deaths among white women under the age of 50 may be related to exposures from microwave ovens and VDTs—both of which are usually operated at chest level. In their response, Castillo and Quencer report that approximately one year after his exposure, the F-16 pilot has made a complete recovery.

COMPATIBILITY & INTERFERENCE

Space Station EMC...NASA is in the midst of soliciting bids for ways of analyzing the EMC of its proposed space station. In the process, the contractor will develop computer-aided engineering software to predict EMI problems *before* they develop. NASA wants to avoid past approaches: either waiting for EMI to occur and then fixing it, or imposing rigid specifications that require wasteful over-engineering with no

guarantee of EMC. Bids on solicitation No. 1-8-EL-93085 were due at NASA's Marshall Space Flight Center in Alabama on August 12.

INTERNATIONAL

Changes at IRPA/INIRC... Dr. Michael Repacholi of the Royal Adelaide Hospital in Australia has taken over from France's Dr. Henri Jammet as the chairman of the International Radiation Protection Association's International Non-Ionizing Radiation Committee (IRPA/INIRC). Jammet has become chairman emeritus. Five new members have been appointed: Drs. Louis Court (France), Alastair McKinlay (U.K.), Michael Shandala (U.S.S.R.), Maria Stuchly (Canada) and Lazlo Szabo (Hungary). (At press time, Shandala and Szabo had not yet officially confirmed their appointments.) They join the following members who will continue to serve on INIRC at least until May 1992 when IRPA holds its 8th Congress in Montreal: Drs. Jürgen Bernhardt (F.R.G.), Branko Bosnjakovic (The Netherlands), Przemyslaw Czerski (U.S.), Martino Grandolfo (Italy), Bengt Knave (Sweden), David Sliney (U.S.) and Jan Stolwijk (U.S.). Drs. Dietrich Harder (F.R.G.) and John Marshall (U.K.) have retired from the committee. France's Annette Duchêne will continue as INIRC's scientific secretary. Dr. John Lakey of the Royal Naval College in the U.K. is the new president of IRPA.

MEDICAL APPLICATIONS

MRI and Eye Implants...A letter in the July 23 issue of *The Lancet* warns that magnetic eye implants can interfere with magnetic resonance imaging (MRI), making it difficult to get an accurate reading of the scan. In addition, strong fields from MRI can displace the implant. Acrylic eye implants should be used in place of magnetic ones, recommend Drs. William Power and L.M.T. Collum of the Royal Victoria Eye and Ear Hospital in Dublin, Ireland.

PEOPLE

Dr. **William Rea**, a Dallas, TX, surgeon who specializes in allergies and clinical ecology with an emphasis on EMFs, has been awarded the U.K.'s first research chair in environmental medicine at the University of Surrey's Robens Institute. Initial funding—£2 million for ten years—is being provided by the Environmental Medicine Foundation. Rea has collaborated with Dr. **Cyril Smith** of the University of Salford and Dr. **Jean Munro**, medical director of the Allergy and Environmental Medicine Hospital in Breakspear College in Hertfordshire, who have shown that weak EMFs can cause allergic reactions that are frequency specific (see *MWN*, M/A87). Munro was formerly with the Environmental Medicine Unit at London's Lister Hospital. Rea will also continue as director of the Environmental Control Unit in Dallas....Dr. **Don Justesen** of the VA Hospital in Kansas City, MO, has been appointed the new editor of *Bioelectromagnetics*. NIEHS's Dr. **Don McRee**, who was originally slated to become the editor, will now be an associate editor....Dr. **Tom Tenforde** has left the Lawrence Berkeley Lab to become the chief scientist at Battelle Pacific Northwest Labs' Life Sciences Center in Richland, WA....Dr. **Joe Lary** is giving up his research position at NIOSH's labs in Cincinnati, OH, to join the agency's grants program in Atlanta, GA.

STANDARDS

LNLL RF/MW Limits... The Lawrence Livermore National Lab has adopted new exposure limits for RF/MW fields and radiation below 300 GHz. The standard appears to be the first to specify guidelines for pulsed EMFs. The LNLL limits for CW radiation are adapted from a recent draft of the ANSI proposal to revise C95.1–1982, according to LLNL's Gordon Miller. The standard also cites exposure limits for 3 kHz-300 MHz that are designed to protect against electric shocks when other safety precautions cannot control them. With respect to pulsed EMFs, two different sets of guidelines are specified, for fewer and for more than 13,000 pulses in an eight-hour shift—these are heavily annotated to address specific cases. Miller told *Microwave News* that the guidelines are probably "too complex for a general use standard." For a copy of Supplement 23.57 to the LLNL *Health & Safety Manual: Radiofrequency/Microwave Radiation and Fields*, issued May 1988, contact: Gordon Miller, LLNL, L-384, PO Box 5505, Livermore, CA 94550.

CISPR and IEC Draft Rules...CISPR has released a six-month draft rule amending CISPR Publication 16, Part I, *Specifications for Radio Interference and Immunity Measuring Equipment*, CISPR/A (Central Office) 47 Parts I & II ($70.00). And IEC's Technical Committee 77 has issued a draft amendment, *Electromagnetic Environment and Compatibility Levels For Low Frequency Conducted Disturbances and Signalling in Public Power Systems*, 77(Central Office)26-27, Parts I & II ($18.00). Copies of both are available (prepaid) from: ANSI, International Sales Department, 1430 Broadway, New York, NY 10018.

ETC...

Lightning Protection?... Lightning kills more Americans each year than any other natural phenomenon, yet there are no standard guidelines for lightning safety, complains an editorial in the July 25 *New York Times*. "Is there no one in Washington's health and science establishment capable of sorting out the confusion and establishing a standard doctrine on lightning safety?" The editorial was prompted by a rash of lightning deaths. The next day, Samuel Huntington, the CEO of New England Electric System, was killed by lightning in Aspen, CO.

"They've known since the early 1970s that EMP is potentially dangerous, but they never advised their personnel of the risk," said Michael Withey of Schroeter, Goldmark & Bender, a Seattle law firm which is representing Strom in cooperation with the Washington, DC-based Trial Lawyers for Public Justice.

According to the complaint, Boeing became aware of the potential health risk associated with EMP exposure when a cluster of leukemia and skin cancer cases developed among a small group of EMP technicians working at a Boeing test site in Montana. At a 1970 *Technical Coordination Conference on EMP Biological Effects* in Albuquerque, NM, Boeing and the others decided to proceed with their EMP research while monitoring the health of technicians. Those who were exposed were given medical exams, but were never told why: "The defendants...have exchanged medical information gathered from these examinations with one another, without the knowledge or consent of the subjects," the complaint charges.

Representatives from Boeing refused to comment on the case.

Strom worked inside a shielded room containing the EMP power supply and pulsers which, he said, were fired hundreds of times a day. "The pulsers were operated with no concern for safety other than high voltage shock hazard since Boeing... provided no information or protection against EMP radiation," Strom charged. In general, the work was characterized by "a lack of training, knowledge and safety information on radiation hazards and by poor engineering design," he said.

"They told me that EMP exposure was safe, but they knew that other Boeing EMP technicians had already gotten leukemia. Ultimately, I got it too," Strom told *Microwave News*.

In 1985, during one of his required company medical examinations, Strom was informed that he had an abnormally high white blood cell count. He was later diagnosed with chronic myelogenous leukemia which he was told gave him a life expectancy of 42 months. Strom was then 45 years old.

In addition to his lawsuit, Strom filed a workers' compensation claim in August 1986 which is still pending. Michael Welch of Tacoma, WA, is handling this claim.

A number of documents obtained by Strom's attorneys indicate the delicacy with which Boeing has handled the EMP hazard issue. A March 1987 Boeing memo—which concerns proposed topics and speakers for a meeting on EMP biological effects (see *MWN*, J/A87)—warns that some EMP health hazard questions could be "an embarrassment to...governmental clients and other attendees of the meeting." It also advises against inviting participants who could be "potentially disruptive."

One document of particular interest is a May 1987 report prepared by Dr. Ralph Coates—then an epidemiologist with Boeing Medical Services. The report, *Exposure to EMP Radiation and Risk of Leukemia and Lymphoma*; chronicles the medical testing of Boeing employees throughout the 1970s and describes four possible leukemia and/or lymphoma cases out of 350 potentially exposed EMP workers—when fewer than one or two cases would be expected in a population of that size during that period of exposure.

Coates, now an assistant professor at the Department of Epidemiology and Biostatistics at Emory University in Decatur, GA, was reluctant to comment directly on the case, but in a telephone interview with *Microwave News*, he said: "There is enough information in the literature on electromagnetic fields to raise the leukemia question with EMP."

Montana Tests

From 1968 to 1972, Boeing—in conjunction with the U.S. Air Force—ran extensive EMP tests on outdoor missile sites in Montana. In his 1977 book, *The Zapping of America*, Paul Brodeur wrote that Boeing was aware as early as 1971 of two cases of leukemia and one case of skin cancer among a group of 17 technicians working at the site. A few years later, two other Montana workers developed leukemia and bladder cancer.

According to Strom's complaint, in September 1972, the National Institute for Occupational Safety and Health (NIOSH) informed Boeing that "there was no justification for assuming that EMP was not a factor in the development of leukemias and skin cancers."

Several EMP technicians who worked in Montana later

EMP Bioeffects Review

A preliminary report on the biological effects of electromagnetic pulse (EMP) radiation concludes that current studies do not "establish that EMPs represent either an occupational or a public health hazard," nor do they indicate acute or short-term health effects.

But the survey, which was prepared by Drs. Tim Aldrich, Clay Easterly, Paul Gailey and Charles Hamilton for the U.S. Department of Energy, cautions that "the appearance that several experimental studies and considerable occupational experience have resolved the EMP health effects question is misleading." Indeed, the survey calls for "more research...to adequately characterize the physical interactions of EMP fields with the body," and states that the "potential for...health effects...will eventually have to be addressed more fully for EMP simulators."

The survey notes that AT&T Bell Labs is planning to raise its EMP exposure limit from 5 kV/m to 100 kV/m to match that of the U.S. Air Force; AT&T has no plans for medical surveillance of exposed workers.

A copy of *Bioelectromagnetic Effects of EMP: Preliminary Findings* is available from: National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. It includes a 31-page appendix with abstracts of EMP bioeffects studies. Aldrich and Easterly are with Oak Ridge National Lab, Gailey is with the EC Corp. and Hamilton is at the University of Tennessee's Department of Health.

told Strom that the leukemia victims had worked extensively in mobile trailers where the pulse tests were run; another EMP worker developed skin cancer on his hand after repeatedly placing it under the sensor to measure the electromagnetic field. Indeed, Strom recalled a co-worker in Seattle with skin cancer on his temple who held his ear next to the pulser during adjustments to hear it fire.

Montana technicians also revealed to Strom that many of them suffered emotional problems and personality changes; Strom said that he too was unaccountably irritable and depressed while working with EMP.

In the early 1970s, Boeing filed a petition with the Occupational Safety and Health Administration (OSHA) asking the agency to set a national EMP exposure standard. OSHA eventually denied the petition on the grounds that "the need for a standard...has not been shown" and that "the scientific information necessary for the development of a standard currently does not exist."

Without federal regulatory guidance, Boeing gradually relaxed its in-house standard; it went from 0.4 kV/m in 1970 to 1 kV/m and then to 5 kV/m over the next seven years. In 1977, the limit was raised to its present 50 kV/m, but Boeing is considering a further increase to match the Air Force's standard of 100 kV/m (see *MWN*, J/A87).

Confounding the issue, Strom also said that while working with the pulsers he was exposed to such an intense level of toxic gases—ozone, hydrogen sulfide and others—that he could identify them by smell. After his diagnosis, Boeing installed vented hoods over the pulser work area.

Brain Cancer *(continued from p.1)*

In a telephone interview, Milham commented that, "Overall, I can't think of any clear bias that would negate Speers's results."

A study by Dr. Terry Thomas of the National Cancer Institute in Bethesda, MD, also showed an association between brain cancer and electrical work, but she rejected EMF exposure as being the responsible agent (see *MWN*, S/O87).

In an editorial appearing in the same issue of the journal, Dr. Baruch Modan of the Department of Clinical Epidemiology at Tel Aviv University Medical School in Israel notes that the Speers, Lin and Milham studies, which may support a "true causal association," are weakened by methodological flaws, including: the lack of assessment of other toxic substances; the fact that other occupational groups (such as truckers) showed elevated risks; and the reliance on death certificates as the primary source of information.

Despite his reservations, Modan writes that "[Electromagnetic] energy, which is with us to stay, must be considered an environmental hazard and dealt with accordingly, until proven otherwise."

Speers's team targeted cancer deaths from 1969 to 1978 with positive diagnoses of primary malignant brain tumors. Although more than half of those initially identified were women, they were eliminated from the study because of the lack of occupational information on their death certificates.

The team grouped the mortalities by occupation and industry and found that, for those in the category of "transportation, communications and utilities occupations," the risk was more than twice the expected rate for unexposed workers, and was statistically significant.

Curiously, the team also found that the risk to workers in the trucking industry was more than six times the expected rate to unexposed workers. None of the other remaining occupational subgroups showed a similar risk elevation.

When asked about the possibility of citizens band (CB) radios being responsible for the increased risk, Speers said she didn't know and added that the trucking finding "should be replicated before too much is made of it." (Note: Many truckers use higher-than-allowed power outputs for their CBs and often place the antennas on the cabs above their heads.)

The team employed an index to estimate EMF exposures —the same one used by Lin in his study. When divided into exposure groups of "none, possible, probable and definite," the analyses yielded, "not only a significant elevated risk of brain cancer but also an increase in risk by probability of exposure." The risk increased from 115% in the possible exposure group (policemen, utility employees, mechanics, plumbers, steelworkers, carpenters and boilermakers) to 286% in the probable group (non-specified engineers in electrical, electronics, aerospace and telecommunications industries). As for the definite group (electric and telephone company employees, electricians and electronic, railroad and telecommunication engineers), there were six cases of brain cancer as compared to none among the controls. This increase was statistically significant at the 0.009 level.

With respect to confounding factors, such as chemical exposures, the team was unable to identify any potential chemical carcinogens for brain cancer associated with electrical work. The team did not, however, discount the possibility that unknown variables—diet, alcohol consumption and tobacco use—played a role.

Marjorie Speers et al., "Occupational Exposures and Brain Cancer Mortality: A Preliminary Study of East Texas Residents," *American Journal of Industrial Medicine, 13*, pp.629-638, June 1988; Baruch Modan, "Editorial: Exposure to Electromagnetic Fields and Brain Malignancy: A Newly Discovered Menace?" *Ibid.*, pp.625-627.

MICROWAVE NEWS is published bimonthly • ISSN 0275-6595 • PO Box 1799, Grand Central Station, New York, NY 10163 • (212) 517-2800 • Editor and Publisher: Louis Slesin, Ph.D.; Associate Editors: Jennifer Goren, Sarah Verdone; Contributing Editor: Mark A. Pinsky; Copy Editors: Peter Pullman, Ann Hornaday; Intern: Fiona Greaves • Subscriptions: $250.00 per year ($285.00 Canada & Foreign, U.S. funds only); single copies: $50.00 • Copyright © 1988 by Louis Slesin • Reproduction in any form is forbidden without written permission. • We invite contributions to *From the Field*, our column featuring news and opinions from the non-ionizing radiation community. Letters from readers are also welcome.

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HAZARDOUS RADIO FREQUENCY ELECTROMAGNETIC RADIATION:
Evaluation, Control, Effects and Standards

Course No. 588DC—November 2-4, 1988 in Washington, D.C. Fee: $815

The rapidly increasing number of RF electromagnetic radiators such as radars and high-power radio broadcast and television stations, the large number of microwave ovens and other consumer and medical RF-generating devices in use, and the increased number of industrial RF applications constitute potential environmental, occupational, and public health hazards. The risks of exposure to intense RF fields for sensitive electronics equipment, ordnance devices, fuels, and people are examined. National defense, security, and law enforcement needs and public demand for increased consumer conveniences suggest that exposure to RF fields will probably increase. The transmission of solar power using EM fields is one of many possible future techniques that may appreciably increase the levels of environmental RF.

The presentation provides broader knowledge and understanding of the sources of RF electromagnetic fields, their transmission and interaction mechanisms, how to detect and quantify the fields, and how to protect equipment and people from their effects. The presentation is basically descriptive, with minimal use of mathematics. Examples of actual RF field surveys, investigation of human potential overexposures, and typical problem solving are provided.

The course is designed for managers, scientists, physicians, attorneys, engineers, industrial hygienists, environmental specialists, security and law enforcement personnel, electronic systems planners, and equipment operators in government, industry, and academe who need better working knowledge of hazardous radio frequency (RF) electromagnetic radiation, its effects, and the means of protecting against it. The course should be especially valuable to members of the medical electronics profession, manufacturers of portable and hand-held radio equipment, and users of test and industrial electronics equipment.

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MICRO WAVE NEWS

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New Listings

ELF-Microwaves and Chemical Promoter Yield Cancerous Cells

Extremely low frequency (ELF) modulated microwave radiation and chemical promoters can transform cells from a normal to a cancerous state, according to researchers at the University of Maryland School of Medicine in Baltimore. Once initiated by microwaves, cells exposed to a chemical cancer promoter—TPA—grow abnormally, like those cells exposed to a chemical carcinogen or ionizing radiation.

This new finding supports previous research showing that microwave radiation can act as a co-carcinogen with chemicals. Epidemiological and animal exposure studies also have indicated a cancer-microwave link.

Up to now, however, most researchers have believed that non-ionizing radiation is more likely to be a cancer promoter than an initiator.

In a paper presented at the *11th Annual Meeting of the Bioelectromagnetics Society*, held in Tucson, AZ, in June, Drs. Elizabeth Balcer-Kubiczek and George Harrison reported a dose-dependent relationship between a 24-hour exposure to 2.45 GHz microwaves and cell transformation at specific absorption rates (SARs) of 0.1-4.4 W/Kg. They found a "possible SAR-threshold for initiation of transformation" between 0.1 and 1 W/Kg.

The 2.45 GHz microwave source used to expose the cells emits 120 pulses per second, with an 8.3 msec pulse width, corresponding to a 120 Hz modulation.[1]

After the conference, Balcer-Kubiczek told *Microwave News* that SARs of 0.1 and 4.4 W/Kg correspond to power densities of 0.065 and 2.8 mW/cm^2— levels well below current exposure standards, such as the 1982 American National Standards Institute guidelines.

(continued on p.14)

OTA on ELF Hazards: "Legitimate Reasons for Concern"

"Electric and magnetic fields produced by electric power systems may pose public health hazards," according to a report by the Congressional Office of Technology Assessment (OTA). The report, which was issued June 19, states that a growing amount of evidence now indicates that, under certain circumstances, even relatively weak extremely low frequency (ELF) fields can cause biological changes and that, although the implications are still unclear, "there are legitimate reasons for concern."

Distribution lines, electric blankets and certain types of wall wiring may play a "far greater role than transmission lines in any public health problem," the report concludes: "To the extent this proves true, it will be important for legislators, regulators and others to take care to think of this

(continued on p.13)

HIGHLIGHTS

U.S.S.R. Accuses U.K. of Irradiating London Embassy

In June, the Soviet Union charged the British government with beaming high-frequency radio waves at Soviet embassy buildings in London to power listening devices planted in the walls. *Izvestia*, the Soviet government newspaper, charged that the microwave bombardment may have caused the deaths of two Soviet citizens.

In an article headlined "Rays Bring Death," *Izvestia* stated that the five-year-old son of a diplomat and a young journalist who worked at the London embassy died suddenly last year, according to a United Press International report published in the June 5 *Philadelphia Inquirer*.

The Soviet embassy also alleged that a young girl who lived in an embassy residence developed leukemia last year and subsequently left the U.K. in a "grave" condition, the June 5 *Irish Times* reported.

The Soviet allegations come in the wake of a May diplomatic incident in which the British government accused eight Soviet diplomats and three Soviet journalists of spying and expelled them from the U.K. The Soviet Union countered by expelling 11 British subjects on suspicion of espionage.

At a June 3 news conference, Soviet diplomats revealed that recent construction work on embassy buildings uncovered a honeycomb of listening devices planted in the walls and deep underground, according to the Associated Press. The British government, however, has denied knowledge of the bugs. Indeed, U.K. Foreign Secretary Sir Geoffrey Howe told a BBC Radio 4 news program that the Soviet announcement was a "rather amateurish" attempt at media manipulation, the *Independent*, a British newspaper, reported on June 5.

The British have used microwave-controlled listening devices in the past, however. In the 1987 book *Spycatcher*, Peter Wright, a former member of MI5—one of the British secret services—wrote that throughout the 1950s, the British (as well as the Americans, Canadians and Australians) used a bugging system known as SATYR, which employed cavity microphones activated by microwaves. Wright described SATYR as "one of the best methods of obtaining coverage." The Thatcher government tried to suppress the publication of Wright's memoirs.

During that period, the Soviet Union began beaming microwaves at the U.S. embassy in Moscow, a practice which lasted for at least 26 years (see *MWN*, Jan81). The irradiation was resumed for a few months at varying frequencies and intensities over the summer of 1983. At that time, the U.S. Ambassador denied that the microwaves posed a health hazard, but he filed a formal protest "as a matter of principle" (see

"Maze" and Mind Control: A Roman à Clef?

"By employing an ELF modulation of a high frequency radio signal, our researchers have discovered that it is possible to bypass the normal sensory mechanisms of certain of the brain's organisms and to influence the brain directly."

So reads a memorandum written for the KGB in a new novel, *Maze*, by Larry Collins, the author of a number of best-sellers, including *O Jerusalem!* and *Is Paris Burning?*

Maze (Simon and Schuster, $19.95) has all the makings of a conventional espionage thriller, except, in this case, the plot is about how the Soviets are trying to find an electromagnetic "brain bomb"—that is, a way to "unlock the combination of [a man's] electromagnetic code" to send the President of the United States into an uncontrollable rage.

The novel is chock-full of electromagnetic arcana. For example, "An Australian named Adey in California gave us the answer [as to how cells interact with ELF fields]. The cell's membranes are covered with strands of proteins tipped with calcium ions. Each strand has a negative electrical charge. Think of them as like ears of corn waving in a field in a summer breeze." Dr. José Delgado also has a featured role.

The CIA, as portrayed by Collins, does not believe a word of all this. The one exception is the protagonist, Dr. Art Bennington, who heads the agency's Behavioral Sciences Division. He has an uphill battle because, as he explains to the director of the CIA: "Our scientific establishment has always said no, these [ELF] frequencies can't affect human beings for one simple reason; their waves are both non-thermal and non-ionizing. Therefore, no heat, no effect. It's as simple as ABC."

When Bennington assumes his cover at Electrobiological Research Associates, a CIA dummy corporation, he takes on the identity of Capt. Eldon Tyler of the U.S. Navy. Of course, he sees enormous potential for ELF and RF weapons: "Believe me, if an unequivocal correlation is ever established between those fields and human behavior, we're going to be faced with something that makes splitting the atom pale in comparison."

No doubt Collins was aware of the CIA's MKULTRA mind control projects of the 1950s and 1960s, and of the persistent charges and countercharges over beaming microwaves at foreign embassies (see above). He has also delved deeply into the science and politics of EMFs. Perhaps he even talked to Navy Capt. Paul Tyler (retired), who has written about EMF weapons, and to the women at the Greenham Common peace camp in England who have charged that they are being "zapped" (*MWN*, S/O86).

In July, *Maze* made a brief appearance on the *New York Times* best-seller list and then dropped out of sight.