MICRO WAVE NEWS

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INSIDE...

New Outlook on Effects of Very Weak Electric Fields

Biological responses due to very weak electric fields "cannot be dismissed" on theoretical grounds, according to Dr. James Weaver of the Massachusetts Institute of Technology (MIT) in Cambridge, MA, and Dr. Dean Astumian of the National Institute of Standards and Technology (NIST) in Gaithersburg, MD.

"We do not explain how the field can have an effect. All we are trying to point out is that the thermal noise limit cannot be used to dismiss the possibility of a real effect being present even at low field strengths," Astumian told *Microwave News*.

In a paper published in the January 26 issue of *Science* (p.459), Weaver and Astumian take aim at the often-used argument that to trigger biological

Special Report: Table of Extremely Low Frequency Magnetic Field Gaussmeters and Dosimeters. See pp.8-9.

changes electric fields must be large enough to overpower random fluctuations. Their simple models indicate that a tiny, but repetitive, electric field concentrated in a narrow band of frequencies (for example, a 10 Hz bandwidth) can trigger transitions in the conformation or shape of macromolecules—especially membrane-bound enzymes.

In a telephone interview, Astumian said that there is "an almost unlimited number of macromolecules whose shape could be influenced by external fields of various frequencies." After all, he pointed out, "proteins,

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Florida's Magnetic Field Limits Challenged as Too Lenient

On December 29, Florida's Hillsborough County challenged the state's power line electromagnetic field (EMF) standards—the first magnetic field limits adopted in the U.S.

In its petition, the county charged that the standards disregard studies showing a potential link between increased cancer risks and magnetic field exposures at levels significantly lower than the specified limits. According to the county, they "do not further the statutorily mandated goal of protecting public health and welfare," because they are "approximately 100 times greater than the intensity of magnetic fields, which are suspected to increase the incidence of all childhood cancer by 30 percent and to double the risk of contracting childhood leukemia."

(continued on p.6)

« Power Line Talk »

It's been a tough few months for those with Department of Energy (**DOE**) contracts. Some of the major labs doing EMF research—including Battelle, Lawrence Berkeley, Loma Linda and Midwest Research Institute—have been caught in a bureaucratic squeeze, with no money coming in since October. Rumors have also been circulating that the DOE might ask **Oak Ridge National Lab** in Tennessee to run the EMF program. December brought the retirement of Dr. **Ken Klein**, who has long shepherded the DOE's EMF effort. On top of all this, the program might be caught up in a bureaucratic reorganization. The researchers have been pushed to the limit: not only can't they pay their bills, but they face losing 10% of their contracts to Oak Ridge as an administrative fee at a time when they don't know if the DOE will be able to keep its EMF research effort afloat. Few of those involved were willing to speak on the record, but one contractor told us that he is doubtful that the Oak Ridge move will ever take place. DOE staffers maintained that the funding snafu was not limited to the EMF program. A new assistant secretary froze funding on all programs until he could be briefed on each one. But meetings with Klein's successor—acting division head **Russ Eaton**—have been repeatedly postponed. At press time, the DOE had begun processing the paperwork to get the EMF money flowing again—though Eaton still hadn't seen the assistant secretary and the contractors still hadn't seen their checks. One contractor speculated that the funding crunch resulted from a combination of Gramm-Rudman budget cuts and a reevaluation of the whole EMF effort. No one knows whether the program will survive in its present state or whether, as one observer put it, it will be "reorganized right out of existence." Meanwhile, the public's concerns about EMF health effects continue to grow. Stay tuned....

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...For instance to power lines on ***Nightline:*** ABC News is planning to air a half-hour segment on its late night news program in late February or early March. Camera crews have already filmed anxious homeowners in Alexandria, VA, who are battling with **Virginia Power** over what they consider to be excessively high magnetic fields in their homes—up to 80 mG, they say. Among others scheduled to be interviewed are Drs. **Keith Florig, Indira Nair, David Savitz** and the New York Power Authority's **James Cunningham.**

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Some physicists are positive that the whole EMF business is a fraud. Dr. **Robert Adair** of Yale University is prominent among them. Here are some of his latest statements: "Anyone who would believe that EMFs could promote cancer would believe in perpetual motion or cold fusion....In my mind, this falls into the realm of aberrant science..." (*Journal of the National Cancer Institute*, November 15). "What I found [at EMF meetings] is there's a lot of very good people who don't believe any of it, and a lot of people who are not well based in science who do experiments that are very difficult to interpret, who then manage to interpret them. It looked like very bad science to me" (*Hartford Courant*, January 25). Adair has been busy studying other issues: Harper & Row recently published his book, *The Physics of Baseball.*

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On the other hand, some physicists *are* willing to consider the possibility of low-level EMF interactions. At this year's **American Physical Society** meeting, there will be a panel on *Health Effects of Non-Ionizing Radiation.* Among those scheduled to speak are Drs. **Ross Adey, Granger Morgan, Tom Tenforde** and **Joe Elder.** The meeting will be held April 16-19 in Washington, DC.

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Many utility customers have been receiving pamphlets explaining the EMF problem along with their electricity bills. And as we have noted before, as often as not, Dr. **David Savitz**

Panel Calls on DOE for Non-Nuclear Epi Research

The Department of Energy (DOE) should allocate $7.5 million in fiscal year 1991 for "new and important areas of energy-related epidemiologic research"—including electromagnetic field (EMF) effects, according to an independent advisory panel.

In an interim report to the DOE, the Secretarial Panel for the Evaluation of Epidemiologic Research Activities (SPEERA) stated that, "Many questions about toxic chemicals, non-nuclear energy and community radiation risks remain unaddressed." Steve Boedigheimer, SPEERA's executive director, told *Microwave News* that, "Non-ionizing radiation is within the scope of research that the panel has flagged."

Although at least two dozen major epidemiological studies of EMFs are now under way worldwide (see *MWN*, N/D89), none of these is funded by the DOE. The DOE's defense programs and Office of Environmental Safety and Health spend $30 million on ionizing radiation epidemiology.

Overall, the panel cited "ample evidence to confirm weaknesses in the department's epidemiology program" and noted that it remains undecided as to whether the program should be moved out of the DOE.

The nine-member panel, which is made up of health professionals from around the country, will issue a final report in mid-March.

is quoted in these tutorials (see *MWN*, S/O89). In a brochure distributed by Commonwealth Electric in Massachusetts, Savitz says: "Using standard levels for scientific proof, the argument that these [EMFs] cause cancer, reproductive damage or other health effects falls far short of convincing."...The **National Electrical Manufacturers Association** (NEMA), one of the newest entrants in the EMF public information campaign, recently mailed its members a Q&A brochure on the *Biological Effects of Electric & Magnetic Fields*. NEMA concludes that, "Despite considerable evidence that there is no risk, there is a need for continuing research." The association is concerned that fear of the unknown could lead to "irrational and damaging public policy decisions."

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What the public really thinks of the EMF risk is best reflected in the way people evaluate real estate near power lines. On this basis, buyers are worried. This is how Charles Baumbach, a San Francisco appraiser, put it in the latest issue of ***Appraisal Views:*** "While the extent of the EMF influence on our health is in dispute, it is already affecting project planning and surrounding property values. In the future, this issue can be expected to grow in significance in the planning process, the courts and the marketplace." The quarterly newsletter is published by Dominy, Ford & McPherson in Houston, TX, as part of a national appraisers' network.

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Writing in the December 16 issue of the ***British Medical Journal***, Stella Lowry decried the scare stories about EMFs that have appeared in the press and said that there is an "urgent" need for high quality epidemiological studies on the "effects, if any," of EMFs on human health. Dr. **Stephen Perry**, a retired English physician who has long studied the possible link between EMFs and suicide, has responded with a warning about a fundamental problem in human studies on low-level field effects—the absence of an unexposed control population. "Power frequency magnetic fields are pervasive throughout the developed world," Perry noted. "Thus all epidemiological research will tend to compare the bad with the worse."

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The National Association of Regulatory Utility Commissioners (**NARUC**) can't make up its mind. Last year, NARUC's electricity committee asked its subcommittee staff to draft a resolution on EMF research. But when the committee members read it, they decided to put it on hold. One staffer told us that he "got the feeling" that the committee "wasn't interested."

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This year, for the first time, the **Maryland** Department of Natural Resources (DNR) will include EMF bioeffects among its list of proposed research topics. The DNR's Power Plant Topical Research Program—which funds environmental research—has a research budget of $400,000, most of which will be distributed in $50,000-$70,000 grants. For more information, contact: Paul Miller, Research Administrator, Chesapeake Bay Research & Monitoring Division, Tawes State Office Bldg., 580 Taylor Ave., Annapolis, MD 21401, (301) 974-3782. (See also *MWN*, M/A89.)

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Utilities have long complained about how reporters cover the EMF issue. Now they must contend with criticism from the art world. On February 14, a New York City gallery is opening a show called ***Our Cells, Our Selves, Our Homes***, by Paul Ludick. It's about electromagnetism, furniture and appliances and features a "cancerous" sofa and love seat. Ludick, who in the past has taken on ozone depletion, told us that "the show is about tumors and mutations." It runs through March 10 at Art & Industrie, 106 Spring St., New York, NY.

Marcy-South "Cancerphobia" Decision Appealed

The Marcy-South 345 kV power line "cancerphobia" lawsuit is going back to court. On December 11, the New York Power Authority (NYPA) appealed the settlement awarded last fall based on noise and loss of view (see *MWN*, S/O89). Three days later, the landowners' attorneys filed a cross appeal raising the health risks issue.

The NYPA is appealing every part of the decision—*except* for the cancer issue, which was rejected by the court. The plaintiffs are using their appeal to argue once again that their land has been devalued because of the fear of cancer associated with power lines.

On September 29, Judge Peter McCabe, Jr., of the New York State Court of Claims in Goshen ruled that the landowners had failed to prove that there is a "reasonable basis for any fear that power lines cause health problems." However, McCabe did approximately triple the NYPA's original offer to one of the landowners.

The NYPA contends that the $123,260 award conflicts with the opinions of its real estate appraisers and was based solely on the "subjective judgment of the court." Carl Rosenbloom of Bond, Schoeneck & King in Washington, DC, is representing the NYPA in its appeal.

Michael A. Gurda of Gurda, Gurda & McBride in Middletown, NY, who represents the 58 landowners, told *Microwave News* that the court "erred on its burden of proof. We shouldn't have to prove [EMFs] cause cancer, just that there is sufficient cause for concern." He added that they probably would not have appealed had the NYPA not done so first.

A decision on the appeals is not expected for at least a year, according to Gurda. In the meantime, the remaining landown-

ers will continue their claims—the next five are scheduled to be heard some time in April.

The appeals were filed in the Appellate Division of the New York State Supreme Court, Second Department, in Brooklyn. For more on the case, see *MWN*, M/A87, J/A88, S/O88 and N/D88.

"Prudent Avoidance" Is Basis for Maryland Power Line Appeal

On December 21, the Maryland Public Service Commission (PSC) gave the Potomac Electric Power Company (PEPCO) the go-ahead to complete the last segment of a 243-mile 500 kV power line loop around Washington, DC. However, on January 22, one day before the order became final, the state Office of People's Counsel (OPC) appealed the decision.

The OPC called for the PSC to adopt a strategy of "prudent avoidance." In so doing, it invoked the Colorado Public Utilities Commission's (PUC) recent adoption of an identical policy (see *MWN*, N/D89). Prudent avoidance has become a rallying cry since it was first proposed in a Congressional Office of Technology report last summer (see *MWN*, J/A89).

In the 84-page decision, PSC Hearing Examiner Teresa Bay granted PEPCO an unconditional certificate, while ordering the PSC staff to monitor future EMF bioeffects research and to file semi-annual reports with the commission beginning July 1, 1990. Bay accepted the recommendations of the state Department of Natural Resources (DNR) staff that the evidence does not support a conclusion of health effects but that "additional research is warranted."

The OPC challenged Bay's decision, arguing that the "evidence clearly is sufficient to justify the commission's adoption of a 'prudent avoidance' policy in this case, and the imposition of conditions which will reduce the magnetic field exposure levels in a reasonable and prudent manner."

"It is not acceptable for the commission to bury its head in the sand on this issue, because of lack of 'proof' and scientific uncertainty," the OPC maintained.

The OPC proposed that the commission "take reasonable steps to minimize the consequences"—including requiring PEPCO to "investigate the feasibility of design changes" or to widen the right-of-way to ensure levels of 10 mG or less at its edge or to reroute the line through a less developed area. Failure to do so "subjects these residents to a long-term biological experiment, with potential short and long-term health consequences," according to the OPC.

Hearing Examiner Bay had rejected these recommendations as "arbitrary and perhaps counterproductive." Citing the California PUC's recent report (see *MWN*, N/D89), she stated that setting magnetic field limits would be "inappropriate."

Last March, the PSC held a hearing on the sole issue of whether operation of the line would cause adverse health effects. Among the participating parties were PEPCO, the OPC, the DNR and Maryland's Howard County (see *MWN*, M/A88 and S/O88; for excerpts from the testimony by the parties' expert witnesses, see *MWN*, J/F89).

Epidemiology Roundup

• While Dr. Michel Coleman and coworkers failed to find a "clear association" between leukemia and residence near electricity transmission and distribution equipment in south London, U.K., they did make some positive observations. For instance, they found a nonsignificant 50% increased risk of leukemia among those under the age of 18 who lived within 50 m of a substation—which is similar to the risk observed in the Savitz study. They also found that people of all ages who lived within 50 m and within 100 m of high-voltage power lines had a 100% and a 45% increased risk of leukemia, respectively. Here again, neither was statistically significant, nor was the trend of increasing risk with proximity to the line. Residents within 25 m of a substation had a 30% increased risk of leukemia, but those within 100 m showed no such elevation. See "Leukaemia and Residence Near Electricity Transmission Equipment: A Case-Control Study," *British Journal of Cancer (BJC), 60*, pp.793-798, 1989. Coleman is at the International Agency for Research on Cancer in Lyon, France.

• In a guest editorial in the same issue of the *BJC*, Dr. Ray Cartwright concluded that, "Present scientific knowledge points at the very best to a minute [leukemia] risk of EMF verging on the point of non-existence." Cartwright, of the U.K.'s Leukaemia Research Fund Centre for Clinical Epidemiology at the University of Leeds, is currently working on a study of leukemia and residential EMF exposures (see *MWN*, N/D89). See "Low Frequency Alternating Electromagnetic Fields and Leukaemia: The Saga So Far," *BJC, 60*, pp.649-651, 1989.

• Preliminary results from a Swiss study of railroad engine drivers indicate increased risks of hematopoietic and lymphatic cancer on the order of 50%, according to Drs. Christoph Minder and Dominik Pfluger of the University of Bern's Department of Social and Preventive Medicine (see *MWN*, N/D89). The researchers estimated the workers' exposures to be several hundred A/m (>1 G). They are planning more detailed measurements.

• It appears "that an association is present between high traffic density and childhood cancer," although the "data do not strongly implicate traffic-related air pollution," Dr. David Savitz and Lisa Feingold concluded in a recent study. The findings were particularly striking for children under the age of five—fivefold increases in leukemias and in brain tumors and a threefold increase in all cancers. Savitz had investi-

gated, and rejected, traffic density as a possible confounder in his landmark Denver childhood cancer-EMF study. See "Association of Childhood Cancer with Residential Traffic Density," *Scandinavian Journal of Work and Environmental Health, 15*, pp.360-363, 1989.

• David Savitz, New Zealand's Neil Pearce and Charles Poole of Epidemiology Resources in Chestnut Hill, MA, explore the ins and outs of EMF studies in "Methodological Issues in the Epidemiology of Electromagnetic Fields and Cancer," *Epidemiologic Reviews, 11*, pp.59-78, 1989.

• Linemen who worked on a 400 kV power line (with average daily exposures of 233 mG and 2.8 kV/m) for one day and on an identical—but unenergized—line the following day showed "no statistically significant" differences in blood chemistry, EEGs and behavioral indices which could be attributed to EMF exposures, according to a study from the Swedish National Institute of Occupational Health. See F. Gamberale et al., "Acute Effects of ELF Electromagnetic Fields: A Field Study of Linemen Working with 400 kV Power Lines," *British Journal of Industrial Medicine, 46*, pp.729-737, 1989.

• A number of epidemiological studies have linked EMFs with brain cancer. And so it was noteworthy that in 1988, Drs. Devra Lee Davis and Joel Schwartz reported an almost threefold increase in brain cancer among white men and women aged 75-84 (*The Lancet, i*, pp.633-636, March 19, 1988). In a November 25, 1989 letter to *The Lancet*, Drs. Anders Ahlbom and Ylva Rodvall of Sweden's Karolinska Institute noted that a Norwegian study had found a similar trend but that in Sweden there was an increase among men, but not among women. They concluded that conflicting results from recent studies "raise the issue of whether or not the increase in brain tumor rates reported by others is real. If it were it would be of considerable importance, both from the public health point of view and scientifically." Ahlbom was a member of the NY Power Lines Project scientific advisory panel. (See also a letter from Italy's F. Levi and C. La Vecchia in the October 14, 1989 *Lancet*.)

• Since electrical technicians and engineers had higher mortality rates due to leukemia than linemen and power station operators who had "presumably" higher EMF exposures, there is probably another agent at work. So argue Dr. Richard Gallagher and colleagues at the Cancer Control Agency of British Columbia, Canada, in a letter to the *Journal of Occupational Medicine, 32*, p.64-65, January 1990. They recommend that, in future studies, researchers consider exposures to chemicals and solvents, as well as to EMFs.

• In a study of varied occupational exposures and cancers, a team of Italian researchers observed no significant association with exposures to electricity and radar. The team did find increased risks for agricultural occupations and for those involving exposures to benzene and other solvents. See C. La Vecchia et al., "Occupation and Lymphoid Neoplasms," *British Journal of Cancer, 60*, pp.385-388, 1989.

Washington State ELF Literature Review Issued

Current research is "inconclusive, but the findings nonetheless are cause for concern." This is how Thomas Sykes and Ping Li of the Washington State Institute for Public Policy (WSIPP) sum up the EMF bioeffects literature in a new survey. Among the report's other findings are that epidemiological studies, for the most part, have shown a "consistent relationship between exposure to electric or magnetic fields and the promotion of cancers," but that the "evidence is not strong enough to validate [this] hypothetical relationship...."

The 41-page January 1990 report, *Possible Health Effects of Electric and Magnetic Fields from Electric Power Lines: A Summary of Scientific Studies*, was ordered by a 1989 state law (see *MWN*, M/A89 and M/J89). For more information, contact: Thomas Sykes, WSIPP, Evergreen State College, Seminar 3162, MS: TA-00, Olympia, WA 98505, (206) 866-6000, ext. 6380.

Project ELF Fully Operational

After more than a quarter century of plans, studies, protests and litigation, the U.S. Navy's Project ELF is operating at full power. With the official opening on October 6 of the second of two extremely low frequency (ELF) transmitters, the Navy now has a communications system capable of reaching submarines at great depths.

The transmitters—one near Clam Lake in northwestern Wisconsin and another near Sawyer Air Force Base south of Marquette, Michigan—are broadcasting at powers up to 2.3 megawatts. The Navy believes this system will provide continuous contact with submarines around the globe in the event of a nuclear weapons attack.

The 28-mile-long transmitter in Wisconsin and the 56-mile-long transmitter in Michigan are considerably smaller than the 6,200 miles of cable and 100 transmitters first proposed in the late 1950s, when the system was known as Project Sanguine. For a short time, it was called Project Seafarer.

Controversy has plagued Project ELF. Opponents, led by John Stauber and Jennifer Speicher of Stop Project ELF, have for years questioned its biological and environmental impacts. In 1984, the state of Wisconsin won a court order forcing the Navy to stop work until it completed a supplement to the environmental impact statement it had filed in 1977. Before that study was completed, however, a federal court

overturned the order—permitting construction to continue—and Supreme Court Justice John Paul Stevens refused to consider an appeal (see *MWN*, S84). Under a contract with the Navy, the American Institute of Biological Sciences completed a literature review on ELF effects in March 1985 (see *MWN*, Mr85).

Magnetic Field Limits Challenged (continued from p.1)

"The primary goal is to invalidate the rule," Edward de la Parte, Jr., who is representing the county, said in an interview. "Beyond that, the county is wrestling with what numbers to suggest to the state Department of Environmental Regulation [DER] if the challenge is successful." De la Parte, of de la Parte & Gilbert in Tampa, FL, is working with County Attorney Frederick Karl, also based in Tampa.

The DER's Buck Oven, who developed the standards, told *Microwave News* that the challenge may be "legally inappropriate and moot," because it is not certain whether the county has standing to oppose the rule.

The Division of Administrative Hearings will hold a two-week hearing on the petition starting May 21. The participating parties are the DER, Florida Electric Coordinating Group (a utility lobby), Florida Power Corporation and Hillsborough County.

The magnetic field limits (and electric field limits) which took effect last March are for new power lines only: they specify a maximum of 150 mG for lines of 230 kV or less, 200 mG for 500 kV lines and 250 mG for certain double-circuit 500 kV lines. The rule exempts existing lines and new lines of 69 kV or less.

The county contended that the DER improperly exempted existing electrical facilities and smaller lines. Magnetic field exposures of 2.5 mG may increase the incidence of childhood cancer, according to the county, yet existing lines and those of less than 69 kV (as well as new lines) "commonly produce fields of greater than 2.5 mG at the boundary of the right-of-way [ROW]."

The standards are significantly weaker than those first proposed by the DER in June 1988, which specified *daily average* and *maximum* limits of 50 mG and 100 mG, respectively (see *MWN*, M/J88). Last year, Oven said that the adopted standards were based on levels that are "technologically achievable" (see *MWN*, M/A89).

Hillsborough County charged that the limits were "increased by the DER in order to accommodate the concerns of the electrical power industry."

The DER's Assistant General Counsel Betsy Hewitt maintained that the DER "considered all the scientific evidence and came up with a rule that reasonably does what it is supposed to do—protect the health and welfare of the public—by preserving the status quo."

The county also charged that, "Florida statutes require that the DER establish magnetic field standards to protect public health and welfare," but, "By the DER's own admission, the magnetic field standards are not reasonably related to either goal."

In addition, it challenged the limits specified for the 500 kV Lake Tarpon-Kathleen line (see *MWN*, M/A89), arguing that although they are more stringent than those set for other new 500 kV lines, they are still higher than fields "now occurring at the edge of similar 500 kV ROWs throughout the state" —contrary to the rule's status quo objective. The county fought against the yet-to-be-built Lake Tarpon line for four years before losing the certification battle last August.

Even if the rule is withdrawn, the Lake Tarpon limits will remain in effect because they were set by the siting board during the certification process, according to Oven.

With regard to the economic issues, the county claimed that the DER's economic impact statement is inadequate because it "fails to address the cost to the public and health care providers of exposing the population of this state to magnetic fields approximately 100 times more intense" than fields suspected of increasing the cancer risk.

On this point, Oven said that, "The economic impact issue should have been raised at the DER hearing a year ago."

Last March, the county issued a challenge to the rule one day after its effective date (see *MWN*, M/A89). The petition was withdrawn in April (see *MWN*, M/J89).

Hillsborough County, FL, v. Dept. of Environmental Regulation, Case No.90-0001R. For more on the Florida standards, see *MWN*, J/A83, J/A84, M/A86 and N/D87.

IRPA Issues Exposure Limits

The International Radiation Protection Association (IRPA) has published its *Interim Guidelines on Limits of Exposure to 50/60 Hz Electric and Magnetic Fields*. The guidelines, which were developed by IRPA's International Non-Ionizing Radiation Committee (INIRC), specify public exposure limits for magnetic and electric fields of 0.1 mT (1,000 mG) and 5 kV/m, respectively.

The interim occupational exposure limits for magnetic fields and electric fields are 0.5 mT (5,000 mG) and 10 kV/m, respectively.

The IRPA committee based its guidelines on "established or predicted effects of exposure to 50/60 Hz fields." With regard to the potential association with cancer, it noted that, "Not only is this association not proven, but present data do not provide any basis for health risk assessment useful for the development of exposure limits."

The IRPA/INIRC guidelines, together with explanatory text, were first published in the May/June 1989 issue of *Microwave News*. The complete IRPA/INIRC statement appears in *Health Physics, 58*, pp.113-122, January 1990.

NEW BOOKS

Brief Reviews

Robert O. Becker, **Cross Currents: The Perils of Electropollution, The Promise of Electromedicine,** Los Angeles, CA: Jeremy P. Tarcher, Inc., 1990, 336 pp., $19.95.

In this sequel to *The Body Electric,* Becker explores the two sides of electrobiology: on the one hand, its application in nontraditional healing techniques and, on the other, the cause for concern over the proliferation of radiation-emitting devices in the modern environment.

Richard B. Borgens et al., **Electric Fields in Vertebrate Repair,** New York, NY: Alan R. Liss, Inc., 1989, 334 pp., $69.50.

Six well-referenced chapters provide an introduction to the biology of endogenous and applied electrical fields and their role in regeneration and healing. The emphasis is on DC fields. The authors are with Purdue University.

Paul Brodeur, **Currents of Death: Power Lines, Computer Terminals and the Attempt To Cover Up Their Threat to Your Health,** New York, NY: Simon & Schuster, 1989, 333 pp., $19.95.

This is the book that everybody is writing and talking about. Excerpts first appeared in *The New Yorker* last June.

James C. Lin, editor, **Electromagnetic Interaction with Biological Systems,** New York, NY: Plenum Press, 1989, 300 pp., $62.50.

The 15 papers assembled by Lin, of the University of Illinois in Chicago, were first presented at the 1987 URSI meeting held in Israel. Of particular interest are contributions by China's Huai Chiang and Binjie Shao on microwave effects on reproduction, development and immunology and by Poland's Stanislaw Szmigielski on Polish and Soviet safety standards.

Shizuo Mizushina, editor, **Non-Invasive Temperature Measurement,** New York, NY: Harwood Academic Publishers, 1989, 144 pp., $70.00.

Four of the eight papers in this collection—from France, Japan and the U.S.—deal with microwave radiometry. The use of ultrasound is also covered.

Eberhard Neumann, Arthur E. Sowers and Carol A. Jordan, editors, **Electroporation and Electrofusion in Cell Biology,** New York, NY: Plenum Press, 1989, 436 pp., $85.00.

In the words of the editors, this volume "covers basic, applied, and instrumentation aspects of electroporation and electrofusion and presents discussions of biological and biophysical model systems." Many of the 27 papers are from West Germany; two are from the U.S.S.R.

Bertil R.R. Persson and Freddy Ståhlberg, **Health and Safety of Clinical NMR Examinations,** Boca Raton, FL: CRC Press, 1989, 175 pp., $110.00.

The Swedish authors have provided the most complete discussion of this subject now available—they cover static, ELF and RF fields, as well as EMI and site-planning issues. One chapter is devoted to safety standards.

Cyril W. Smith and Simon Best, **Electromagnetic Man: Health & Hazard in the Electrical Environment,** London, U.K.: J.M. Dent & Sons, Ltd., 1989, 344 pp., £17.95. [Available in the U.S. for $29.95 from: St. Martin's Press, New York, NY, (212) 674-5151, ext. 661.]

Smith, a physicist at the University of Salford, and Best, a science journalist, give a comprehensive overview of the health effects of EMFs—with a special emphasis on the role of homeopathic medicine (in, for example, the treatment of electrical allergies). Other topics covered include the military's use of NIER, the effects of chronic EMF exposures and international safety standards.

Gustav Freiherr von Pohl, **Earth Currents: Causative Factor of Cancer and Other Diseases,** Stuttgart, F.R.G.: Frech-Verlag, 1987, 159 pp., $14.00 (approximate).

An exploration of Pohl's hypothesis that "negative electrical earth currents" cause cancer and a variety of other ailments in humans, animals and plants. Most of the book is devoted to case studies. It was first published in German in 1932.

Bary Wilson, Richard Stevens and Larry Anderson, editors, **Extremely Low Frequency Electromagnetic Fields: The Question of Cancer,** Columbus, OH: Battelle Press, 1990, 382 pp., $57.50. [Order from: (800) 451-3543.]

The three editors, from the Battelle Pacific Northwest Lab in Richland, WA, also wrote much of this timely book. For the rest, they enlisted some of the best-known names in the EMF community: Adey, Blackman, Groh, Liboff and Tenforde. Other leading researchers—including Blask, Hammond and Reiter—also contributed chapters.

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ELF Gaussmeters and Dosimeters

Company, Address, Contact	Meter Name	Price	Bandwidth (other bands)	Min-Max/ No. of Scales	Accuracy†	Size/Weight (in/lbs)	Options/Comments
F.W. Bell, Inc. 6120 Hanging Moss Rd., Orlando, FL 32807 (407) 678-6900 Contact: Steve Dakel	Model 4048 Model 9200 Model 9500 Model 9903	$650.00 $1,500.00 $2,800.00 $5,800.00	0-12 kHz 10 Hz-10 kHz 20 Hz-10 kHz 20 Hz-50 kHz	0.1 G-20 kG/3 10 mG-20 kG/4 1 mG-300 kG/6 1 mG-3 MG/7	± 2.5%‡ ± 2.5%‡ ± 1%‡ ± 1%‡	4x7x1.8/1 8.8x4.5x11/8 14x7.5x14/19 18x7.5x16/36	All models are Hall Effect devices. All can measure DC fields. All except the 4048 can output to an oscilloscope.
Combinova AB[1], c/o Ergonomics, Inc. PO Box 964, Southampton, PA 18966 (215) 357-5124; FAX (215) 364-7582 Contact: Frances George	MFM10	$6,700.00	5 Hz-1 kHz	0.1 mG-10 G/4	<± 2%	15.2x4.6x10 /6.6	Data can be stored and transferred to computer.
Electric Field Measurements Box 326, W. Stockbridge, MA 01266 (413) 637-1929; FAX (413) 637-2826 Contact: Dr. Don Deno	Model 116 Model 116+ EMDEX-C[2]	$75.00 $250.00 $2,000.00	60 Hz 60 Hz# 40-400 Hz#	0.1 mG-200 G/4 0.1 mG-200 G/4 0.1 mG-25 G/4	± 3% ± 3% ± 3%	1.5x1.5x2/0.4 4.75x2.5x9/2 1.8x4.8x6.5/1.3	116 sensor plugs into std. digital multimeter. 116+ includes multimeter. EMDEX stores data. Waveform capture device.*
Electric Power Research Institute (EPRI) PO Box 10412, Palo Alto, CA 94303 (415) 855-2581; FAX (415) 855-1069 Contact: Dr. Stan Sussman	3D-AMEX*	To be determined	40-800 Hz	0.35-150 mG/ (not applicable)	± 5%	1x2x4/0.3	Fits in shirt pocket. Requires separate readout unit.
Electro-Magnetics Design, Inc. 9100 W. Bloomington Freeway, Bloomington, MN 55431, (612) 888-7473 Contact: Roger Hastings	ACGM-1 ACGM-2	$450.00 $990.00	20-150 Hz 20-150 Hz	0.1 mG-9 G/2 0.1 µG-9 G/3	± 1% ± 1%	2x4x7/1 2x4x7/1	Autoranging. LCD readout.
Holaday Industries, Inc. 14825 Martin Dr., Eden Prairie, MN 55344 (612) 934-4920; FAX (612) 934-3604 Contact: Burton Gran	HI-3600-02	$1,195.00	50/60 Hz#	0.1 mG-20 G/5	± 5%	1.8x3.5x17/2.8 (with 8" diameter sensor)	Remote readout. Signal output for dB/dt measurements. VDT/ VLF version available.
Integrity Electronics and Research, Inc. 558 Breckenridge St., Buffalo, NY 14222 (716) 886-7283 Contact: Tom Valone	IER-109	$595.00	55-65 Hz	1 µG-2G/4	± 2%	3x4x7/0.9	LCD display. E-field module and 3-access probe available. IER-119 available for 50 Hz.
MacIntyre Electronics Design Associates, Inc. 11260 Roger Bacon Dr., Reston, VA 22090 (703) 471-1445 Contact: Barbara Vayda	µMAG	$495.00	0-100 Hz	10 µG-2 G/3	± 0.5 %	4x7.5x2/0.9	Model with earth field neutralization available for $649.00.

Company, Address, Contact	Meter Name	Price	Bandwidth (other bands)	Min-Max/ No. of Scales	Accuracy†	Size/Weight (in/lbs)	Options/Comments
Monitor Industries 6112 Fourmile Canyon, Boulder, CO 80302 (303) 442-3773 Contact: Ed Leeper	Model 42B	$350.00	40 Hz-1 kHz	0.01 mG-2.5 G/ 12	± 7-10%	2.1x3.1x7.8/ 1.8	Audio speaker. Model 42B-1 with linear frequency response available for $425.00.
Positron Industries, Inc. 5101 Buchan St., Montréal, Quebec H4P 2R9, Canada, (514) 345-2200; FAX (514) 731-8662 Contact: Silvo Frank	"Dosimeter" 378101	$1,650.00†	60 Hz# (5-20 MHz)	60 µG-4 G/ automatic	± 5%	6x3x1/0.5	Output to computer. Stores 18 days of data. Model 378102 available for 50 Hz.
Safe Computing Co. 368 Hillside Ave., Needham, MA 02194 (617) 444-7778, (800) 222-3003 Contact: George Lechter	Safe Meter	$145.00	20 Hz-30 kHz (5-70 kHz)	1 µG-230 mG/7	± 5%	6x3x4/0.7	Safe meter readings must be converted to mG with hand-held table. Both meters rent for $29.95/wk.
	Professional Meter	$175.00	5 Hz-1 kHz (1-40 kHz)	0.1-200 mG/1	± 3%	5.5x3.3x1.5/0.8	
Schaefer Applied Technology 200 Milton St., Unit 8R, Dedham, MA 02026 (617) 320-9900, (800) 366-5500 Contact: John Schaefer	Model EM1	$89.95 (Rents for $40.00/wk)	10 Hz-1 kHz	0.45-10+ mG/1	± 5%	5.5x3x1.5/0.8	Specifies level in 1 of 10 ranges between 0.45 and 10 mG, or greater than 10 mG. Model EM10 has large remote display.
Shoden Corp. 2-23, Ojima 1-chome, koto-ku, Tokyo 136, Japan (03) 637-7711; FAX (03) 637-7724 Contact: Massy Fujiwara	MFM-12A	$1,700.00†	60 Hz (25 Hz-10 kHz)	0.1 mG-20 G/3	± 5%	6x4x2/3	50 Hz meter available. Outputs to oscilloscope and recorder are standard.
Sydkraft AB Carl Gustafs Väg 4, S-217 01 Malmö, Sweden (40) 25 58 96; FAX (40) 97 47 74 Contact: Bo Wiberg	MFDM	$1,850.00	50/60 Hz	10 µG-20 G/5	± 5%	16x12x5/2	150/180 Hz included. The program can be made to suit different requirements.
	3D MFDM	$9,500.00	50/60 Hz	10 µG-2 G/ automatic	± 2%	24x17x8/24	
Walker Scientific, Inc. Rockdale St., Worcester, MA 01606 (508) 852-3674, (800) 962-4638; FAX: (508) 856-9931 Contact: Joe Nowlan	ELF-50 Field Monitor	$179.95	50/60 Hz	1 mG-51.2 G/2	± 1%	6x3.3x1.5/0.5	ELF-50 digital display available for $225.00. For MF-5D, probes designed for specific applications are available.
	MF-5D Fluxmeter	$1,665.00	0-100 kHz	0.1 mG-200 kG /3	± 1%	2.8x8.5x9.3/5	

† Approximate.
§ Accurancy decreases as frequency rises.
# Also measures electric fields.
* Under development. Available later in 1990.

1. The address in Sweden is: PO Box 20050, S-161 20 Bromma, Sweden, (08) 733-9310.

2. Sold under license from EPRI.

HIGHLIGHTS

PMFs and Pregnancy: Clues Emerge, Conflicts Persist

A coherent picture of the effects of pulsed magnetic fields (PMFs) on pregnancy continues to elude researchers, though some clues on the interaction are beginning to emerge. Specifically, the timing of the exposure and the genetic makeup of the target species appear to be key variables.

In his latest series of experiments—in which pregnant mice were exposed to a sawtooth 20 kHz magnetic field with a peak field strength of 15 μT—Dr. Hakon Frölen of the Swedish Agricultural University in Uppsala found that delaying PMF exposure until the ninth day after conception resulted in no harm to the embryos. This differs from his previous findings, reported over the last few years, in which he consistently saw increases in fetal deaths and resorptions with early exposure (see *MWN*, J/A87 and S/O88).

Last September, at a conference on video display terminal (VDT) work and health, held in Montreal, Canada, Frölen explained that he continued to see ill effects when he started PMF exposure on the first, second or fifth day of pregnancy—but not if he waited until the ninth day.

This early pregnancy effect agrees with the results of experiments using chick embryos carried out by Dr. Alexander Martin of the University of Western Ontario in London, Canada, and by Dr. Jocelyne Leal of the Ramón y Cajal Hospital in Madrid, Spain (see *MWN*, N/D88). In a recent paper, Martin reported that the first 24 hours of development were the critical period for the chick's susceptibility to PMFs. Exposure on the second day after fertilization caused no effect.

The second/third day of development for the chick is approximately equivalent to the eighth/ninth day for the mouse, Martin told *Microwave News*. "The cell processes in the chick and the mouse are basically the same as far as cell proliferation and differentiation are concerned," he said. At the November Department of Energy-Electric Power Research Institute (DOE-EPRI) review in Portland, OR, Martin reported that 60 Hz sinusoidal fields did not increase the malformation rate among chick embryos.

Also at the DOE-EPRI meeting, Murray Walsh of Ontario Hydro reported that the mouse pregnancies were totally unaffected by 20 kHz PMFs at 3.6 μT, 17 μT and 200 μT. There were no increases in malformations, resorptions, fetal deaths or any other indices. The study was led by Dr. Michael Wiley of the University of Toronto and was sponsored by the Canadian utility and IBM.

Essentially the same mouse study has now been carried out in three different labs in Sweden and Canada. Dr. Bernhard Tribukait of the Karolinska Institute in Stockholm, Sweden, was the first to report that weak 20 kHz sawtooth fields are biologically active—he reported an increase in serious malformations (see *MWN*, M/A86 and M/J86). Each laboratory used a different strain of mice, however, leading Frölen and Martin to hypothesize that genetics may be the reason for the variation in results.

This view is supported by the results of Project Henhouse, in which six different labs used the same protocol to test the effects of PMFs on chick embryos (see *MWN*, M/A88). The one lab which failed to find any effect used a different strain of eggs from the others. "The genetics of the egg could help explain the inconsistent results reported by several labs," Martin said at the Portland meeting.

Sweden's Dr. Ingrid Nordenson of the University of Umeå and Dr. Kjell Hansson Mild of the National Institute of Occupational Health in Umeå have documented a nearly threefold increase in chromosomal aberrations in human amniotic cells exposed to 30 μT sinusoidal 50 Hz magnetic fields. This result was highly significant ($p<0.001$). There was also an increase following exposure to 16 μT 20 kHz sawtooth PMFs, but this effect was only significant at the $p=0.06$ level. At last summer's Bioelectromagnetics Society meeting, they reported that neither waveform affected protein synthesis, but that the sawtooth PMF did affect DNA synthesis.

EPA RF Survey in McFarland

The Environmental Protection Agency (EPA) found only nanowatt levels of radiofrequency (RF) radiation in McFarland, CA, the site of a well-publicized childhood cancer cluster (see *MWN*, J/F88, J/A88 and M/A89).

The strongest fields, 3-19 nW/cm^2, were associated with UHF television transmissions—levels "commonly found in most urban areas," according to EPA. AM radio signals contributed 2-8 nW/cm^2. Voice of America shortwave broadcasts from a facility in nearby Delano produced much lower levels—0.2-1.3 nW/cm^2. FM radio fields were 0.001-0.006 nW/cm^2. These data are consistent with informal measurements taken in 1988 (see *MWN*, S/O88).

The cause of the cluster remains unexplained. "Many of the avenues of investigation have been exhausted," Dr. Rick Kreutzer of the Epidemiological Studies and Surveillance Branch of the California Department of Health Services told *Microwave News*. He said the state previously had failed to uncover anything unexpected in the air, water or soil—the same now holds true for the RF environment.

The investigation is now focusing on determining the cancer rates—from 1980 to 1989—in four counties in the region. Kreutzer explained that if the elevated cancer rates are related to agricultural pesticides, then the whole area—not just McFarland—would probably be affected. Some preliminary results are due in the spring.

EPA's report, *Radiofrequency Radiation Survey in the McFarland, California Area* (EPA/520/6-89/022, November 1989), was prepared by Edwin Mantiply of EPA's Las Vegas, NV, office and Norbert Hankin of EPA's Washington, DC, office. Copies are available from: Lynne Keeton, Office of Radiation Programs, EPA, PO Box 98517, Las Vegas, NV 89193, (702) 798-2476.

FCC Sets Rules for Multiple RF Sources and "Hot Spots"

The Federal Communications Commission (FCC) has adopted final regulations that exempt some low-level radio-frequency (RF) sources located among other more powerful sources from having to comply with its environmental regulations. The new rules were released on January 18 and will take effect on April 18.

The FCC also provided guidelines for measuring RF "hot spots" to determine compliance with safety limits.

The rules will have the most direct effect on low-power transmitters in antenna "farms" where the combined RF levels may exceed the 1982 American National Standards Institute (ANSI) guidelines for human exposures.

The FCC will now automatically exempt all sources which contribute 1% or less of the ANSI limits from conducting environmental assessments. Low-power transmitters also will be excused from measures needed to comply with the exposure standard.

Hammett & Edison, a San Francisco consulting engineering firm, petitioned the FCC to address these issues in 1987 (see *MWN*, S/O87). The commission responded with a proposed rule in September 1988 (see *MWN*, S/O88). The final rule is essentially the same as the proposal.

Hammett & Edison had recommended a 5% threshold, but the FCC concluded that, "It is better to err on the side of caution" and that, "in this case, the difference between 1% and 5% appears to be significant." The FCC's Dr. Robert Cleveland told *Microwave News* that information provided by the Environmental Protection Agency showed that a 5% threshold is "too lenient and difficult to justify."

In its new rules, the FCC also advises license holders on the proper distance at which to measure "hot spots" caused by the reradiation of RF fields from metal objects. Electing not to set fixed rules, the FCC suggests a guideline of 20 cm for the separation distance between a reradiating object and a meter's sensing device. But the commission adds that measurements at 10-20 cm are "acceptable," particularly in determining partial-body exposures, while cautioning that measurements at less than 20 cm "can exaggerate and inaccurately reflect" whole-body exposures. The commission recommends posting warning signs in "any area where there is an indication of excessive fields" measured at 10-20 cm.

Some observers are concerned that the commission is sending mixed signals on the hot spots issue. Dane Ericksen of Hammett & Edison is disappointed that the FCC has adopted "ambiguous wording on the minimum spacing." And Ric Tell, a consultant based in Las Vegas, told *Microwave News* that, "It's appalling that the FCC has been wishy-washy in specifying the measurement distance."

For more information, contact: Dr. Robert Cleveland, FCC, 1919 M St., NW, Washington, DC 20554, (202) 653-8169.

FROM THE FIELD

Low-Level EMFs: Replies to the Royal Swedish Academy of Sciences

In our last issue, we published the concluding statement of the Royal Swedish Academy of Sciences' workshop on Interaction Mechanisms of Low-Level Electromagnetic Fields (EMFs) in Living Systems—Resonant Phenomena, *held in Stockholm May 25-27, 1989. The statement, which was sent to us by Dr. Bengt Nordén of the Chalmers University of Technology in Göteborg and Dr. Claes Ramel of Stockholm University, prompted the following replies:*

Dear Sir:

As a participant in the workshop, I am surprised that the academy would publish this summary without offering participants the usual courtesy of reviewing its accuracy and scientific perspective or an opportunity to reach an expert consensus.

I was first made aware of this document in November 1989, through the courtesy of the editor of *Microwave News*. My inquiries of four other U.S.—and some Swedish—participants indicate that they were unaware of the document's existence prior to its submission for publication.

The following remarks reflect a deep collegial desire to communicate certain concerns shared by other participants. Because Swedish science holds a preeminent world position in the field of bioelectromagnetics—as in so many other areas of science—it is of great importance that a public statement from the workshop should accurately reflect the current state of knowledge.

I respectfully plead that this statement is an eclectic selection of virtually unrelated topics. It fails to acknowledge that there is a body of connected cell biology on mechanisms of interactions, pointing to the cell membrane as the locus of EMF activity. EMF effects on inward signals act on ionic mechanisms, on intramembranous proteins including specific receptor proteins and on signal coupling to a spectrum of intracellular enzymes. EMFs interact with outward signals in gap-junction mechanisms mediating intercellular communication and regulating cell growth.

I am concerned that readers may be convinced that all that lies between epidemiology and cyclotron resonance models "shows no clear or reproducible pattern of results" because the document fails to address the very existence of significant bioeffects at athermal field exposure levels, as well as their marked frequency and amplitude dependencies. These findings strongly point to long-range, nonlinear physical interactions at the atomic level, rather than to chemical reactions in the fabric of biomolecules.

This summary appears to trivialize as a vast wasteland all research except epidemiology and cyclotron resonance models. This view contrasts with that of the U.S. Congressional Office of Technology Assessment, which, in a June 1989 report, singled out cell membrane studies as of special significance and characterized research on biological effects of power frequency EMFs as being, for the most part, "of very high quality."

Nor should the epidemiological findings be dismissed as indicating only "a slight overall increase in the relative risk of cancer." Recent reports of a tenfold increase in brain cancer risks among certain electronics workers (Thomas, 1987) and a sevenfold higher risk of leukemia among telephone cable splicers (Matanoski, 1989) argue otherwise.

It would seem inappropriate to single out the cyclotron resonance model as the pivotal theory capable of experimental evaluation. Low-frequency sensitivities have also been described in models that bridge from high-frequency coherent oscillations (millimeter microwave) to low-frequency manifestations in Lotka-Volterra models (Fröhlich, 1975, 1977); in similar bridges between high- and low-frequency oscillations in limit cycle behavior of calcium ions (Kaczmarek, 1976); in local superconductivity (Achimowicz et al., 1977); in chaotic behavior of molecular oscillations (Kaiser, 1984); and in microwave effects on red cell membrane enzyme activity consistent with coherent oscillations at 10^{11} Hz (Blinowska et al., 1985). Lednev (1989) offers an exciting new vista on cyclotron-like resonances in coordination compounds between calcium ions and proteins in the presence of fixed and oscillating EMFs.

Is it not in the realm of fantasy to recommend that future research focus on possible effects "on well-characterized systems at the lowest possible levels of complexity"? This belies the challenging evidence that observed sensitivities to low-frequency EMFs are intrinsic to complex ordering of proteins and lipids in membrane structures.

Though sensitive and even painful, some final questions may be raised. Since Professors Nordén and Ramel have no apparent records of published bioelectromagnetic research, and since many participants were excluded from preparation of the summary, were they assisted in its preparation by others, and if so, by whom? In view of the international importance attaching to the academy's conclusions in a matter of such great public interest and scientific importance, is it not unusual to arrange publication in a newsletter that circulates within a narrow segment of the scientific and engineering communities?

We earnestly hope that the academy will offer a sorely-needed forum for continuing scrutiny of the evolving science of bioelectromagnetics. It was indeed a privilege to present our findings in the great halls of the Royal Swedish Academy of Sciences, founded 250 years ago, with its proud traditions of pioneering support in many areas of the physical and biological sciences.

The workshop papers, now in Professor Ramel's hands for publication, contain detailed analyses and critical syntheses that may lead to a somewhat different emergent overview.

Sincerely,
W. Ross Adey, MD
VA Medical Center, Loma Linda, CA

Dear Sir:

During the Royal Swedish Academy of Sciences' workshop, one entire day was devoted to a brisk discussion of mechanisms that might account for the variety of cellular and epidemiological results presented by the speakers. Much of this centered around the cyclotron resonance ideas of Liboff and coworkers.

As the discussion unfolded, led in large part by Herman Schwan, it became clear that if mechanisms of interaction could not be devised to account for the many interesting and puzzling results presented at the meeting, then perhaps the results were of little interest or were maybe even spurious. As I listened, I realized that the physicists were the stumbling blocks. They argued that results like ours did not fit with their reading of the laws of physics. Our findings were therefore not considered "real." It was my impression that these conclusions were based on a preconceived notion that the electric field is responsible for the cellular effects. No one was much interested in considering the possibility that the magnetic field could in fact be causing these highly specific and statistically significant observations.

As a biologist, I don't understand why biological effects such as those observed in my and Ann Henderson's laboratory are received with such skepticism by physical scientists. When we present these data to other biologists, they are not astounded, nor do they call upon us to swear up and down that we have indeed stimulated an increase in specific transcripts. After all, biologists who study responses to stress, such as heat shock, see similar, but different, kinds of changes. Yet when our findings were presented at the workshop, the physicists and engineers greeted them with disbelief. In contrast, the biologists in Stockholm were most receptive—unfortunately, there were only a handful present.

At the end of the meeting I was one of six or seven people involved in the preparation of a summary statement. We all agreed that understanding the mechanism of EMF interaction is important and that it will come as more data appeared. It was *never* considered that, in the absence of a mechanism, what we had reported was a *non-effect*.

It has become clear that the academy has shifted its position on its decision to publish the proceedings. Soon after I returned home, I was asked by Professor Ramel to provide the academy with a manuscript of my talk. I immediately did so with considerable care and effort. I never heard from the academy again and my manuscript seems to be in limbo somewhere.

At least some members of the academy appear to have changed their minds—without the courtesy of telling us. They have judged our scientific research and found us guilty of not being able to explain our results with a mechanism that meets their approval. By implication, our data are suspect or may not even be real.

Professors Ramel and Nordén have selectively chosen unrepresentative examples out of three very exciting days of presentations. In so doing, they have trashed highly interesting results because they found the suggested models wanting.

Sincerely,
Reba Goodman, PhD
Columbia University Health Sciences, New York, NY

Dear Sir:

I have mixed feelings about the conclusions reached by the Royal Swedish Academy of Sciences following the May workshop. As a participant I was moved by the abundant hospitality shown by the hosts, particularly Dr. Claes Ramel. It says worlds about Swedish science that I have never attended an American conference in this area—whether sponsored by BEMS, DOE, DOD or EPRI—that even came close to matching this Stockholm meeting. I had the feeling that at long last I was attending a scientific meeting, and not one of the dog-and-pony shows that we attend regularly in the U.S.

Nevertheless, despite its excellent planning and quality, there are some disturbing aspects to what has happened since this meeting:

(a) Manuscripts were submitted by the participants with the understanding that these would be formally published in either journal or book form. To the best of my knowledge, there has been little or no movement to date to publish the proceedings. One hopes that this delay has more to do with simple human inertia and that there are no hidden, constraining forces at work—objections perhaps to the content of the various presentations.

(b) One can honestly criticize the way in which the meeting was summarized. I am not sure that any scientific gathering at which diverse points of view are hotly contested can be neatly summarized in a completely objective manner, and perhaps the organizers should have been wise enough not to try. If the manuscripts had been promptly moved toward publication, then the sense of the meeting would have been properly judged by the scientific community. Instead, the organizers chose to delay the proceedings and give us the benefit of *their* conclusions. It is a little disturbing that we have now seen two versions of these conclusions. It is very disturbing to recall the efforts towards the end of the workshop to assemble a group charged with issuing a consensus statement. I am not sure how this group was chosen, but I think it had something to do with who caught the first metro train back from the meeting site.

(c) The statement by Nordén and Ramel might have been more representative of the tone of the workshop if they had seen fit to emphasize the positive instead of the negative. No one denies the lack of an acceptable "physical-chemical" model to explain the ELF interaction but how many still doubt the influence of weak ELF magnetic fields? It may have escaped Nordén's attention that the acceptance of effects per se by the larger scientific community is itself noteworthy and remarkable, quite independent of the poor physical understanding of the underlying mechanism. Science is as much *observing* as it is *understanding*. In physics, especially, one finds wide gaps between experiment and theory. Unfortunately, in the present area, there is a small cadre of theorists who reject the experimental data simply because they cannot frame a proper explanation for the results. Nordén and Ramel have unwittingly acted to reinforce this position by emphasizing the negative, or "controversial" aspects. However, the careful, painstaking efforts of Adey, Blackman, Goodman, etc. should not be forced to suffer the sins of theorists who fail to keep pace.

(d) The conclusions suggest a number of research strategies. Because of concern over the "widely different nature and level of complexity" of the ELF studies, a more "systematic approach" is proposed in which different groups "coordinate their work." It seems to me that the one major previous attempt along these lines, the New York State Power Lines Project (NYPLP), turned into a near fiasco. I recall, in particular, the well-meaning consultants who set up exposure systems and left them in the hands of well-meaning life scientists who didn't have the foggiest notion of what happened when they switched the systems on or off. My opinion is that the most reliable NYPLP experiments were the ones that were *less* coordinated. Good science is done by good scientists, not by good scientific committees.

It is indeed a pity that Nordén and Ramel neglected the meeting's *lengthy discussion on the role of epidemiology. Now that the epi*demiologists have convinced most of us that ELF hazards exist (the Matanoski data persuaded me), is it prudent to spend limited funding on more and more epi studies without comparable expenditures on basic research? There are now 22 epi studies under way worldwide. Are there half as many basic science studies funded? Judging from the little we know of the mechanisms involved, it is unrealistic to assume that epidemiology alone will ever help us untangle what is happening at the *physical, biochemical and physiological levels of inter*action. If we ever hope to do more for the public and the power industry other than suggest "prudent avoidance," a lot more laboratory work has to be done.

Sincerely,
Abraham R. Liboff, PhD
Oakland University, Rochester, MI

Conference Reports from France and Bulgaria

Dr. Charles Polk, professor of electrical engineering at the University of Rhode Island in Kingston, filed the following reports after attending the Bioelectrochemical Society's 10th International Conference on Bioelectrochemistry and Bioenergetics *in Pont-à-Mousson, France, September 24-29, 1989, and the* International School on Electromagnetic Fields and Biomembranes *in Pleven, Bulgaria, October 2-8, 1989.*

Bioelectrochemistry and Bioenergetics–France

A substantial part of this meeting was devoted to the discussion of cell electroporation and closely related topics. The increasing interest in this area has been stimulated by the use of very large electric (E) fields (hundreds of kV/m) to temporarily fuse cells for the transfer of genetic material in preparations where cells are surrounded by a low conductivity fluid.

Efforts directed towards optimizing this technique have led to very active research on membrane behavior. The objective of this research is to understand what happens when porosity is increased substantially—but only for a very brief period—so that the cell remains viable. Some of this work deals with membrane structure and basic membrane processes and is of interest also to those who normally work with the comparatively very low intensity E-fields used in tissue repair. For example, Eberhard Neumann and coworkers at the University of Bielefeld, F.R.G., pointed out that the DNA-counterion system is rapidly polarizable.

J. Teissié of the Center for Biochemistry and Cellular Genetics in Toulouse, France, argued that cell fusion following electroporation is a consequence of a decrease of repulsive hydration forces by the E-field which disturbs the regular organization of water molecules. He indicated that it is normally hydration forces which prevent contact between cell membranes and that these forces, as well as electrostatic repulsion, are opposed by van der Waals forces.

In the context of electroporation and cell fusion, Sianette Kwee of the University of Aarhus, Denmark, identified effects of "low E-fields" as those caused by fields of 20-40 kV/m! In a paper which does not appear in the abstract bulletin, Yuri Chizmadzhev of the A.N. Frumkin Institute of Electrochemistry at the U.S.S.R. Academy of Sciences in Moscow reported that the average time required to change the ion conductivity by an E-field pulse is less than one μsec, while the time necessary to change the average pore diameter is about 10 msec. He indicated that the resealing time (i.e., time required for pore disappearance) is highly variable for different lipid membranes, but is generally above 10 sec.

Several papers addressed photosynthesis, electroluminescence and other effects of visible light in biomembranes. For example, Vlad Brumfeld and Israel Miller of Israel's Weizmann Institute of Science inferred the electrophoretic mobility of rhodopsin molecules inside vesicle membranes from differences in photoluminescence in the presence and absence of "low amplitude" (8 kV/m) msec pulses. Michael Drain and coworkers at Rockefeller University in New York City discussed photogating of ionic currents across a lipid bilayer and showed that currents of large hydrophobic ions depend upon photoinduced charge generation inside the membrane.

The discussion of electrical and electromagnetic stimulation of bone and tissue repair by Heinrich Berg, Martin Blank, Reba Goodman, Ann Henderson, Charles Polk, Sol Pollack, Joseph Spadaro,

Mays Swicord, Tom Tenforde and Bernard Veyret identified two regions of E-field amplitude where effects have been observed. E-fields at frequencies from a few Hz to 100 kHz with amplitudes between 0.01 V/m and 10 V/m have been shown to produce various biological responses. These results are considered non-controversial because the corresponding current densities are well above the endogenous levels (~10^{-3} A/m^2).

Effects at lower field intensities, down to 10^{-6} V/m, such as the calcium efflux "window effects" observed by Ross Adey and Carl Blackman and some of the Goodman-Henderson observations showing modification of cellular protein synthesis, are difficult to explain because they correspond to levels below thermal noise. Probably non-equilibrium thermodynamic processes and processes involving considerable amplification via field effects on enzymes play a role in these "ultra-low" field intensity effects, most of which seem to appear only in the presence of an alternating magnetic (B) field.

Veyret, of the University of Bordeaux, France, reported on experiments designed to explain results obtained with the "Priore apparatus" which produced considerable public discussion in France a few years ago. Apparently, a series of well-controlled experiments by reputable biologists confirmed that this apparatus did stimulate parts of the vertebrate immune system. When Priore died in 1983, detailed information on the electrical and magnetic characteristics of his apparatus was lost—although it is known that the device simultaneously used a steady (DC) B-field and a 9.4 GHz microwave (MW) carrier modulated at various frequencies in the MHz range. Veyret's group now studies only the effects of modulated MWs on the immune system of mice at a power level of 30 μW/cm^2, corresponding to a specific absorption rate (SAR) of 0.015 W/Kg—well below the threshold of 0.4 W/Kg for thermal effects. Veyret's laboratory uses 1 μsec pulses at 1 msec intervals with a 9.46 GHz carrier modulated at various frequencies in the MHz range. Modulations at 21 and 32 MHz stimulate immune response, while modulations at other frequencies between 14 and 41 MHz depress the immune system.

Electromagnetic Fields and Biomembranes–Bulgaria

At this conference more than half of the papers were devoted to electroporation and electrically stimulated cell fusion, reflecting the substantial interest in biotechnology within the eastern bloc countries. Many of these papers came from various agricultural research institutes.

Among the papers dealing with "low" field intensities (i.e., those less than 1 kV/m), I found the following particularly interesting:
(1) A one-hour lecture by Valeri Lednev, head of the Laboratory of Muscle Biophysics at the U.S.S.R. Academy of Sciences' Institute of Biological Physics in Puschino, on "Parametric Resonance" was possibly the most important paper presented at the Pleven conference. It provided a quantitative explanation of the various experiments by Abe Liboff's group, which appears to be theoretically much more plausible than the cyclotron resonance mechanisms proposed by Liboff and Bruce McLeod. Based on earlier (1960) published Russian work, it showed that E- and B-fields at specified frequencies can affect transitions between vibrational states of an ion within the molecule to which it is bound.
(2) Y.A. Kholodov of the Institute of Higher Nervous Activity, U.S.S.R. Academy of Sciences, Moscow, reported on the response of human volunteers exposed during randomly-spaced 60 sec periods to DC B-fields of up to 120 mT and AC B-fields of 0.1-5 mT. Kholodov recorded the subjects' EEGs and their verbal descriptions of sensations, including pain. He pointed out that the melanin pigment in the substantia nigra (where serotonin is produced) is one of the very few paramagnetic proteins.
(3) Ruggero Cadossi of the University of Modena, Italy, summarized information presented earlier at the U.S. BRAGS meeting on the effect of triangular B-field pulses (20 G, 3 msec rise time, 7 msec decay time) on the immune system. He emphasized that the nature of observed effects (i.e., lymphocyte proliferation) critically depends upon when the signal is applied during the cell cycle.
(4) Igor Varayev and O.V. Betsky, both of the Institute of Radio Engineering and Electronics, U.S.S.R. Academy of Sciences, Moscow, reported on a variety of experiments showing interaction of MWs at non-thermal levels with living systems. They observed "resonances" or "window effects" at 41.2 and 70.45 GHz in E-coli (increased rates of cell division), genetic effects in Drosophila at 46 GHz and blocking of the repair mechanism for DNA after radiation damage at 51.7 GHz. In experiments in which E-coli DNA was exposed to polarized E-fields at 51.78 GHz, they observed changes in conformation, but no breaks. Experiments on cell membranes, employing millimeter waves at power levels of 0.5-10 mW/cm^2, showed "resonant frequency effects" only in living, and never in dead, tissue. They also stated that some observed resonance effects correspond to transitions between rotational energy levels in water.
(5) I. Klavinsh of the Institute of Biology, Latvian Academy of Sciences, Riga, U.S.S.R., described his B-field device, which is in clinical use for bone and tissue healing. The system consists of a pair of semiflexible coils and a very compact signal generator which plugs into the European standard 220 V, 50 Hz power outlet. The device generates 1 mT B-field pulses with a rise time of 0.5 msec and a decay time of 0.6 msec, repeated either at 80 Hz or at a rate which varies between 40 Hz and 120 Hz. Klavinsh claimed that variation of the repetition rate is essential to obtain the desired physiological effects.
(6) Fritz Pliquett of Leipzig, G.D.R., reviewed pulse techniques for measuring the electrical parameters of biological tissue—conductivity and dielectric permittivity.

UPDATES

INTERNATIONAL

The Non-Ionizing Decade... The U.K.'s National Radiological Protection Board (NRPB) has included a new chapter on non-ionizing radiation in the fourth edition of its 62-page booklet, *Living With Radiation* (1989). The NRPB takes a conservative view of NIER risks, explaining that epidemiological data are "equivocal" and that the risks of exposure, "if real, are within the range regarded by society as tolerable." The booklet is available for £3.50 from: Her Majesty's Stationery Office (HMSO), Publications Centre, PO Box 276, London SW8 5DT, U.K. (01) 622-3316....An interesting contrast to the booklet is an editorial that appeared in the NRPB's January 1990 *Radiological Protection Bulletin*. The unsigned commentary welcomes the new decade by suggesting that, "The 1990s might be the decade of non-ionizing radiation." For more information, contact: NRPB Information Services, Chilton, Didcot, Oxon OX11 ORQ, U.K., (0235) 831600.

MEETINGS

EMF Effects, West Germany... An international cast of researchers is expected to speak at the April 1-7 symposium on *Electromagnetic Field Effects on Molecules and Biological Cells*, to be held at the University of Bielefeld, F.R.G. Among the topics to be covered are mechanisms of interaction and weak field effects. Contact: Dr. E. Neumann, Faculty of Chemistry, University of Bielefeld, PO Box 8640, D-4800 Bielefeld 1, F.R.G., (0521) 106-2053.

PEOPLE

Dr. **Herbert Pollack**, 84, died on January 2 of cardiac arrest. A charter member of both the Electromagnetic Radiation Management Advisory Council and the Bioelectromagnetics Society, Pollack is most widely remembered as a consultant to the State Department in the 1970s on the irradiation of the U.S. embassy in Moscow. He also advised NASA, the USAF and the Office of Telecommunications Policy and served on a number of ANSI subcommittees setting standards for RF/MW exposures. A faculty member at the George Washington University medical school from 1964 to 1970, and a professor emeritus thereafter, Pollack also consulted on nutrition and health to the Surgeon General, the World Health Organization and numerous other institutions worldwide. He received an MD from Cornell University and a PhD in Physiology from the University of Minnesota.

Professor **T. Dvoràk**, the longtime organizer of the biennial EMC symposia in Zurich, Switzerland, has retired from the Institute for Communication Technology, where he had worked since 1969. The 1991 symposium will be chaired by Dr. **G. Meyer**. Professor **P. Leuthold** will serve as the president of the symposium and Professor **Ralph Showers** once again will be the technical chairman.

RESOURCES

PEMF Review... Dr. Andrew Bassett of the Bioelectric Research Center in Riverdale, NY, has published a comprehensive review of the "Fundamental and Practical Aspects of Therapeutic Uses of Pulsed Electromagnetic Fields (PEMFs)" in *Critical Reviews in Biomedical Engineering* (*17*, pp.451-529, 1989). The paper, which includes 330 references, was refereed by Dr. Ross Adey of the VA Medical Center in Loma Linda, CA.

Ionizing Radiation... The National Research Council's Committee on the Biological Effects of Ionizing Radiation (BEIR) recently issued its fifth report on the health effects of ionizing radiation, which concludes that the risk of developing cancer following exposure to low levels of X-rays and gamma rays is three to four times higher than previously estimated. *Health Effects of Exposure to Low Levels of Ionizing Radiation*, known as *BEIR V*, is available for $35.00 (paperback) or $40.00 (hardcover) from: National Academy Press, 2101 Constitution Ave., NW, Washington, DC 20418, (800) 624-6242, or (202) 334-3313....The Senate's Committee on Governmental Affairs has published *Early Health Problems of the U.S. Nuclear Weapons Industry and Their Implications for Today* (Senate Print 101-63). The 16-page report is available from: U.S. Government Printing Office, Washington, DC 20402.

Mind Control... Larry Collins, the author of *Maze*, a roman à clef on the use of ELF to control behavior (see *MWN*, J/A89), has now written a nonfictional version. See the January 1990 issue of *Playboy*.

STANDARDS

New Zealand RF/MW Standard... The New Zealand government has proposed adopting most of the 1985 Australian RF/MW exposure standard. (The Australian standard covers 300 kHz-300 GHz, but the New Zealand proposal apparently covers just 300 kHz-100 GHz.) Along with the exposure standard, New Zealand is seeking comments on adopting Australia's *Principles and Methods of Measurement—300 kHz to 100 GHz*. The Standards Association of New Zealand has asked for comments on *Radio Frequency Radiation, Part 1: Maximum Exposure Levels—300kHz to 100 GHz* (DZ 6609.1) and *Part II: Principles and Methods of Measurement —300 kHz to 100 GHz* (DZ 6609.2). The Australian standard, *Maximum Exposure Levels—Radiofrequency Radiation—300 kHz to 300 GHz* (AS 2772-1985), is "flat" at 1 mW/cm^2 from 30 MHz to 300 GHz (see *MWN*, M/A86). Comments on the New Zealand drafts were due by February 16. For more information, contact: C. Gorman, Standards Association of New Zealand, Private Bag, Wellington, New Zealand, (04) 842-108.

lipids and DNA are all electrically sensitive and their action depends on their topology."

By assuming that a molecule is sensitive to specific frequencies and that a cellular mechanism exists for the signal to elicit a cumulative effect over time, Weaver and Astumian have devised models which show that thresholds for electric field effects can be lowered by a factor of 100,000 below the thermal noise level—to levels as low as 4×10^{-6} V/m at 100 Hz and 10^{-6} V/m at 1 kHz.

In their paper, they illustrate the action of the field this way: "A reaction that is poorly catalyzed may normally proceed at a negligible rate, but the rate may increase significantly upon a field-induced conformation change of the enzyme. Each cycle produces a 'pulse' of product that may accumulate on one side of the membrane...."

The optimal coupling would occur in the range of 100 Hz to 1 MHz, based on the relaxation times of transitions between different structural arrangements of enzymes, according to Weaver and Astumian. Very little research has been carried out on this part of the electromagnetic spectrum, however. "I have always been surprised that people have not focused more on these frequencies," Astumian, a member of NIST's Bioprocessing Metrology Group, said.

When asked about the model's possible implications for magnetic fields, Weaver, who is affiliated with the Harvard-MIT Division of Health Sciences and Technology, replied, "It's hard to make the case for direct low-level magnetic field effects."

Interestingly, the Weaver-Astumian model implies that one would expect to see frequency windows like those identified by Drs. Ross Adey and Carl Blackman. "Amplitude windows are more puzzling," Astumian pointed out.

"Research has been stymied because people have not accepted that these effects could possibly be real," Astumian said. "Now we need a lot of experiments." The other major part of the problem, added Weaver, is that the funding for research has been very poor.

Science magazine is widely read in the scientific community and the Weaver-Astumian paper has attracted much interest—especially as it was featured on the journal's "This Week in Science" page. The entry began, "Do the electric and magnetic fields that are produced by common household appliances, video displays, electric blankets, utility power lines, radar emitters and other sources pose significant hazards to health?"

(Note that figures 2 and 3 on p.461 of the Weaver-Astumian paper are reversed.)

CLASSIFIEDS