MICRO WAVE NEWS

Vol. VIII No. 1 A Report on Non-Ionizing Radiation January/February 1988

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California Cancer Cluster: Is RF Radiation Involved?

An abnormally high rate of childhood cancer has been documented in the small agricultural town of McFarland, in Kern County, southern California, but despite years of intense study, health officials have been unable to identify the cause of the cluster. Investigators have focused almost exclusively on chemical pollutants without success. Nor can they explain why McFarland is different from the dozens of similar farming towns spread throughout the San Joaquin valley.

A number of experts – as well as some McFarland residents – believe that a high-power Voice of America (VOA) shortwave transmitter in nearby Delano may play a role in the etiology of the cluster. The Delano VOA station, which is approximately four miles from McFarland, has transmitters with nearly two million watts in total output sending radio programs to Asia and to Latin America.

Three 250 kW transmitters broadcast southeast to Central and South America at 9 and 11 MHz for approximately four hours each day, according to Lynn Smith, the Delano station manager. McFarland is southeast of the VOA transmitter site – the Latin American signals are beamed over the town. (There are also four other 250 kW transmitters, as well as one 100 kW and two 50 kW transmitters.)

Radiation Is as Likely as Chemicals

In a report on the cluster released on January 28, the California Department of Health Services states that it could not "establish a causal link between any specific factor and development of the cancers." The state discounts the possible impact of radiofrequency (RF) radiation. "We don't think that the evidence that we looked at points at all in the direction of non-ionizing radiation as a problem," Dr. Raymond Neutra, the head of the state health department's Epidemiological Studies and Surveillance Section (ESSS) told *Microwave News*.

Others are not so sure. In a telephone interview, Dr. Ross Adey said that, "RF radiation is a significant factor that has not been taken seriously." Adey, the associate chief of staff for R&D at the VA Medical Center in Loma Linda, CA, has been following the McFarland investigation with keen interest for a number of years. "It is possible that the VOA radiation could have an effect on the people living in McFarland," he said. According to his very rough calculations, the ambient levels of RF radiation are in the microwatt per square centimeter ($\mu W/cm^2$) range in the town, and he points out that, "There are no animal or human studies related to prolonged intermittent exposures at these levels."

An electrical engineer at Ranger Communications, an electromagnetic

(continued on p.14)

HIGHLIGHTS

Should Non-Ionizing Radiation Risk Research Be Halted?

Arguing that microwave (MW) radiation is "one of the most thoroughly studied of all potential environmental hazards" and that "fundamental questions are still being raised about the very existence of hazards associated with low levels of exposure," Drs. Kenneth Foster and William Pickard argue that it is perhaps time to make "the conscious decision to leave some questions unanswered."

Foster, of the University of Pennsylvania in Philadelphia, and Pickard, of Washington University in St. Louis, MO, make their case in a commentary, "Microwaves: The Risks of Risk Research," published in the December 10, 1987 issue of *Nature*. The two professors, both engineers, cite three examples of bioeffects which were reported to occur at levels allowed under the 1982 American National Standards Institute (ANSI) standard: microwave auditory, heart rate and blood brain barrier (BBB) effects. In each case, they conclude that there is no low-level hazard.

Foster and Pickard (F&P) say that there are many other effects – "perhaps hundreds," including many associated with 50/60 Hz power line electric and magnetic fields – that remain to be studied. They sum up: "Granted, society must search for hazards of its technologies. But how to cope with the scientific noise that these studies produce? Such searches for hazards can go on too long, and guidelines for ending them must be established."

This commentary has provoked a great deal of controversy within the bioelectromagnetics community. (Foster prompted a similar dispute after he and Dr. Bill Guy published "The Microwave Problem" in the September 1986 *Scientific American* – see *MWN*, November/December 1986 and July/August 1987.) *Microwave News* polled the community for views on the commentary. Some declined the invitation; others were willing to be quoted.

Dr. Ross Adey, Veterans Administration: Had it not been published in *Nature*, F&P's paper would be better ignored. This and the previous paper in *Scientific American* breach the two essential tenets on which the scientific method has grown to credibility: The investigators shall be thoroughly informed on the state of knowledge in the field and shall present it competently and fairly; and a paper submitted for publication shall be competently peer-reviewed. *Scientific American* and *Nature* are read and accepted as authoritative by a vast worldwide audience of leaders in all fields of science. It is our individual and collective obligation to cleanse the taint of F&P's willful misrepresentation from the scientific literature no matter what it entails.

Dr. Robert Becker, Becker Biomagnetics: F&P have chosen to view the whole question of MW-induced health hazards based on only three effects. Since they find a lack of unanimity on the existence of these effects, they conclude that further risk analysis is unwarranted. They have ignored the literature on other effects of much greater significance as well as that ample body of literature indicating actual risks present in the human population. This paper has *no* relationship to risk analysis and F&P display a narrowness of vision common to mechanistic engineers: "If there is no demonstrable mechanism of action, there can be no risk." The question they address is too important to be left to such an incomplete and unscientific review, particularly one that reaches such an unwarranted and dangerous conclusion.

Dr. Martin Blank, Columbia University: Everyone has priorities in research but it is inappropriate for a scientist to call for "halting" research.

Dr. David Carpenter, New York Department of Health: What they are reacting to is the poor quality of some of the research that gets done. I agree with this. We should improve our standards. We need better quality controls in what gets funded and published. But I would take issue with cutting off research. It is always a mistake to shut off a whole field of research.

Dr. Stephen Cleary, Virginia Commonwealth University: I am surprised that it was published in a scientific journal since it appears to be completely counter to what I understand to be the principles of objective inquiry. In opposition to the views of the authors, I for one have not spent my career searching for "hazards." Considering the present level of support for this type of research, who needs guidelines to end it? If they were needed, who would write them? Considering the apparent difficulty encountered in writing safety standards, I do not anticipate guidelines to end research in my lifetime.

Dr. P. Czerski, Food and Drug Administration: I think this commentary confuses science and research directed to gain fundamental knowledge about EMF interactions and living systems and short-term applied research which arises out of political pressure. In a nutshell, the scientific and societal issues are confused in this article....They are entitled to their point of view, however historical experience (e.g., Michurin and Lysenko) shows that developing guidelines for halting socially undesirable research is a risky enterprise. Societal issues are best solved by democratic means and open discussion.

Dr. Christopher Davis, University of Maryland: F&P have been very subjectively selective about the three phenomena

they chose. The auditory effect is irrelevant to risks due to low-level MWs. The heart rate is not a mainstream experiment in bioeffects research and the BBB, while getting a lot of people excited, has not been confirmed. There are well-documented effects, especially in terms of genetic effects and calcium ion efflux.

Dr. Richard Frankel, MIT: I don't know why they left out the really interesting verifiable effect on calcium efflux, which is leading down a real scientific path.

Dr. Reba Goodman, Columbia University: Given the magnitude of the problems raised by low-level MW radiation and the potential environmental and health hazards, F&P's propositions are extremely unscientific and anti-intellectual. They suggest a moratorium because there are inconsistent findings and occasional modified conclusions. This is common to all research. Oddly enough, *Nature* has consistently failed to publish significant articles dealing with this branch of science. Instead, it has chosen to devote some of its valuable space to F&P's thesis.

Dr. Don Justesen, Veterans Administration: F&P purport to identify a scientific need to shut down unnecessary "risk" research. I'm disappointed in their commentary for several reasons. One, the tacit assumption that investigations in these areas were wholly motivated by hygienic concerns is invalid. Most scientists are driven primarily by curiosity – by a desire to establish and understand functional relations. Second, F&P's history is flawed; in my opinion, they sometimes don't "tell it like it is" – or was. And finally, F&P are guilty of finding fault without offering solutions.

Dr. Samuel Koslov, Johns Hopkins University Applied Physics Laboratory: I get the impression that the authors have not bothered to follow the field for at least five years. The defense of the 1982 ANSI standard seems rather futile in that the NCRP, Canada, Sweden and many local standards have deviated from it, often with recognition of flaws in physical reasoning. The most remarkable aspect of the article is that the advocacy position seems to be to define guidelines to end the search for hazards despite unexplained observations. This is a new line of thinking in science for me.

Dr. Jocelyne Leal, Centro 'Ramon y Cajal' (Spain): This subject of research is not very different from any other subject. In neurophysiology, for example, you can find thousands of results that could not be confirmed, others contradictory and still others due to artifacts. Such outcomes are intrinsic to any experimental research. We are working in a young science, frequently stumbling! But can we afford to deny its importance? From the moment that there is a suggestion that EMFs can affect living organisms, it must be investigated. This is the main responsibility of the scientific community and developed societies.

Dr. Granger Morgan, Carnegie-Mellon University: As you know from my *Science* editorial (*232*, p.917, May 23, 1986), I think starting and stopping rules for federally-funded risk-motivated applied research are important. I wish that F&P had drawn a sharper distinction between such programs and basic science, where the considerations are very different. In the case of risk-motivated applied research on 60 Hz, we have some good examples of such rules not operating well enough. Work on animal perception studies went on longer than needed and work on animal cancer promotion has been too slow in starting.

Dr. John Osepchuk, Raytheon Research Division: An excellent article. It points to a real problem in the field. I am sure the authors are not calling for a cessation of research except that which leads to fruitless research or to ephemeral results. Instead, I am sure they support research that leads to a permanent and reliable data base.

Dr. Richard Phillips, Environmental Protection Agency: It is a biased article. It is a disservice to the other people in the field and to F&P. I don't understand why they wrote it.

Dr. Asher Sheppard, Veterans Administration: F&P attack some straw men in setting up MW effects on hearing, heart rate and BBB as potential hazards. They then tell us these effects can be "explained" as artifacts or denigrated as the expression of contentiousness by a few. Of course, they fail to mention evidence concerning cancer, genetic effects or the altered permeability of eye tissues; nor do they credit the wealth of good research which has come out of inquiry into high- and low-level effects....I am dismayed that the readers of *Nature*, who do not know the limited scope which F&P bring to their pronouncements, will not realize their views are merely provocations from a know-nothing fringe. In a word, it's a "smear."

Dr. Maria Stuchly, Health and Welfare Canada: I have not read anything new there. They carry their assessment too far. I do not share their opinion overall.

Dr. Mays Swicord, Food and Drug Administration: As the authors suggest, the literature contains thousands of reports of RF bioeffect studies of varying quality and results. One can of course prove any point by selectively drawing from such a data base. To do so is either scientifically naive or dishonest.

Dr. Tom Tenforde, Lawrence Berkeley Laboratory: I find it discouraging that two talented scientists such as F&P should take such a dim view of research on the biological effects of microwave radiation. Their point that much confusion has been generated by research that was incomplete or poorly conducted is undoubtedly correct. However, the fact there are unresolved issues in this field argues for more research, not less!

IRPA Relaxes RF/MW Standard

The International Radiation Protection Association's International Non-Ionizing Radiation Committee (IRPA/INIRC) has relaxed some provisions of its 1984 "interim" radiofrequency and microwave (RF/MW) radiation exposure guidelines, especially with respect to low frequency exposures and peak pulsed fields.

Occupational limits are now 614 V/m and 1.6/f A/m for 100 kHz-1 MHz electric and magnetic fields, respectively, and 614/f V/m and 1.6/f A/m for 1-10 MHz (where f= frequency in MHz). There is a provision that if there are risks of RF burns, they can be eliminated "in most situations" by reducing the electric field to 194 V/m for 100 kHz-1 MHz and to $194/f^{1/2}$ V/m for 1-10 MHz.

In the 1984 standard, the two sets of limits were reversed: occupational limits for 100 kHz-1 MHz were 194 V/m and 0.51 A/m for electric and magnetic fields, respectively, and $194/f^{1/2}$ V/m and $0.51/f^{1/2}$ A/m for 1-10 MHz, with the advisory that the limits could be exceeded up to 615 V/m or 1.6 A/m, "provided workers take the necessary precautions to prevent potentially severe RF burns."

Dr. P. Czerski, of the Food and Drug Administration's Center for Devices and Radiological Health and a member of the IRPA/INIRC, told *Microwave News* that by directly addressing the low frequency risks, the limits could be loosened at low frequencies. He explained that the standard is now "more precise." He added that, "It is a loosening predicated on the additional criteria of exposure."

For the general population, the 1984 and 1988 guidelines are identical except for the magnetic field limit between 100 kHz and 1 MHz, which has now been loosened from 0.23 A/m to $0.23/f^{1/2}$ A/m.

The other major change is that the suggested peak pulsed field should not be greater than 1,000 times the six-minute average power density. The 1984 interim limits suggested that the pulsed field should not be more than 100 times greater. Czerski argued that the reduction was needed because the 1984 limit was "too strict, with no good rationale."

In a statement accompanying the new guidelines, the IRPA/INIRC notes that its guidelines are still based on a 0.4 W/Kg whole-body average specific absorption rate (WBA-SAR) because: "A close scrutiny of the available data revealed no need to revise the previously adopted basic WBA-SAR."

The guidelines specify that excessive heating of wrists and ankles can be avoided by limiting body-to-ground currents to 200 mA. The IRPA/INIRC advises that, "In general, RF burns will not occur from currents on point contact of 50 mA or less." The committee notes that a simple ammeter is "sufficient" to verify the maximum current flow.

The IRPA/INIRC considered the potential risks of cancer and congenital abnormalities and concludes that, "Available data are inconclusive and cannot be used for establishing exposure limits."

"Guidelines on Limits of Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 100 kHz to 300 GHz" appears in the January 1988 issue of *Health Physics*. The 1984 guidelines appeared in the journal's April 1984 issue (see *MWN*, March 1984). Members of the IRPA/INIRC are: H.P. Jammet, chairman, France; J. Bernhardt, Federal Republic of Germany; B.F.M. Bosnjakovic, The Netherlands; P. Czerski, U.S.A.; M. Grandolfo, Italy; D. Harder, Federal Republic of Germany; B. Knave, Sweden; J. Marshall, Great Britain; M.H. Repacholi, Australia; D.H. Sliney, U.S.A.; J.A.J. Stolwijk, U.S.A.; A.S. Duchêne, scientific secretary, France.

Radar Radiation Exposure & Unexplained Memory Loss

A pilot who was overexposed to microwave radiation experienced neurological problems long after other overt symptoms disappeared. In a letter to the *Journal of the American Medical Association* (January 15), Drs. Mauricio Castillo and Robert Quencer describe the case of an F-16 pilot who was accidentally exposed to radar radiation.

The 42-year-old civil air patrol pilot felt a moderate heat sensation after standing in front of an F-16's functioning radar system for five minutes last summer. The next morning he noticed a tender lump in his lower neck, which continued to grow and cause discomfort. Over the following month, the lump persisted and the pilot experienced a loss of short-term memory and extreme sleepiness. A doctor found a second small lump at the base of his tongue and diagnosed his condition as being caused by a thermal insult.

The patient's symptoms, which also included the inflammation of his pharynx and vocal chords, disappeared with time – except his memory loss which persisted. A magnetic resonance scan of his brain was normal, however.

This was a "disruptive event" for the patient, Dr. Castillo told *Microwave News*. "He would go shopping and would not know how to get home. He had to carry a card with his wife's telephone number to find out how to get back." But Dr. Castillo added that the patient's memory was improving when he last spoke to him in October.

Dr. Castillo, a radiologist, and Dr. Quencer, who is the head of the Magnetic Resonance Imaging Center, are both at the University of Miami School of Medicine's Jackson Memorial Hospital in Florida. (See also the special report on radiation accidents on pp.10-11.)

LLNL Guidelines for Exposures to Static Magnetic Fields

The Lawrence Livermore National Laboratory (LLNL) has adopted guidelines for exposures to static magnetic fields. The peak allowable exposure limit is 2T, and areas where

fields exceed 50 mT are limited to authorized personnel only.

Writing in the December 1987 issue of the *American Industrial Hygiene Association Journal*, LLNL's Gordon Miller reports that the time-weighted average (TWA) for the trunk is 60 mT. He explains that this guideline is based on limiting the magnetohydrodynamic (MHD) voltage to 1 mV, a level tolerated by primates without evidence of ill effects. It is a "conservative criterion," according to Miller, since it is also based on the assumption that an obese person engaged in sustained moderately heavy work and exposed to 60 mT will experience a voltage rise of 1 mV. The 2T limit is based on the patient-exposure recommendation of Dr. Tom Budinger of the Lawrence Berkeley Laboratory.

Miller cites a warning level of 1 mT for people with pacemakers or prosthetic implants. He explains the rationale thus: "1) Warning at the 0.5 mT level would have meant blocking off a major road on site; 2) no artificial pacemaker has been identified that has a reed switch that functions below 1.4 mT; and 3) the quality assurance testing of reed switches is exceptionally stringent."

Miller cautions that these static field guidelines "cannot be used as standards." He explains that, "The exposure criteria will need to be revised when the results of further research are available." He advocates continued research because of the likelihood that the introduction of superconductors will result in an increase in the number of people exposed.

Miller also reviews time-varying magnetic fields and concludes:

> It is also reasonable to suggest that setting guidelines for time-varying magnetic (and electric) fields would be imprudent until the results of animal exposure studies verify or disprove the hypothesis that time-varying fields are mutagenic, carcinogenic, or teratogenic, and the mechanisms by which such fields do harm have been demonstrated beyond reasonable doubt.

CISPR, ISM & Barriers to Trade

The International Special Committee on Radio Interference (CISPR) has called for "urgent action" to review its radiation emission limits for industrial, scientific and medical (ISM) equipment.

In its latest publication (CISPR 23), the committee notes that, "It is evident that equipment which is incapable of being made to meet CISPR limits is being used in practically every country in the world," but also that, "the number of interference complaints which are traceable to ISM equipment is very low compared with that from other sources." In other words, the current standards are not being met, but it does not seem to make a difference in terms of observable electromagnetic interference (EMI).

CISPR calls the present situation "unsatisfactory" and worries that its limits are overly strict and are being used as technical barriers to trade on an ad hoc basis.

Liliane Volcy of the Federal Communications Commission (FCC), who has been monitoring CISPR ISM developments, told *Microwave News* that past attempts to revise the CISPR ISM limits have failed and that the prospects for the future also look dim. The U.S. has voted against the revisions because they are too vague and because the specifications can be misrepresented and may lead to potential abuse in their application. Volcy explained that, "It is a myth that the U.S. standards are weaker that those of CISPR. They are specified differently and cannot be readily compared."

Volcy said that there have been cases of CISPR standards being used to prevent the export of U.S. equipment – notably, medical and welding equipment. When asked if the U.S. has retaliated to control imports, she said that this has not happened, though "the growing protection mood in the U.S. might force some type of retaliation."

Copies of *Determination of Limits for Industrial, Scientific and Medical Equipment* (CISPR 23) are available for $36.00 each (prepaid), including postage and handling, from: American National Standards Institute, International Sales Department, 1430 Broadway, New York, NY 10018, (212) 642-4900.

CONFERENCES

New Listings

March 8-9: **First International Conference on Formulating Food for the Microwave Oven,** Drake Hotel, Chicago, IL. Contact: The Packing Group Inc., PO Box 345, Milltown, NJ 08850, (201) 636-0885.

June 20-22: **18th Power Modulator Symposium,** Hyatt Hotel, Hilton Head Island, SC. Contact: Leslie Gallo, Palisades Institute for Research, 2011 Crystal Dr., Suite 307, Arlington, VA 22202, (703) 769-5580.

August 8-12: **Non-Ionizing Radiations: Biophysical and Biological Basis, Applications and Hazards in Medicine and Industry,** MIT, Cambridge, MA. Contact: Director of Summer Sessions, Room E19-356, MIT, Cambridge, MA 02139.

August 10-12: **Symposium on Antenna Technology and Applied Electromagnetics,** University of Manitoba, Winnipeg, Canada. Contact: Professor L. Shafai, Dept. of Electrical Engineering, University of Manitoba, Winnipeg, Manitoba, R3T 2N2, Canada, (204) 474-9615.

August 20-26: **7th Annual Scientific Meeting and Exhibition of the Society of Magnetic Resonance in Medicine (SMRM),** San Francisco Hilton & Towers, San Francisco, CA. Contact: SMRM, 15 Shattuck Sq., Suite 204, Berkeley, CA 94704, (415) 841-1899.

September 27-29: **10th Annual Electrical Overstress/Electrostatic Discharge Symposium,** Marriott Hotel, Anaheim, CA. Contact: Michael Martin, 3M/Static Control Systems Division, 2111 W. Braker Lane, Bldg. 501, PO Box 2963, Austin, TX 78769, (512) 834-3117.

March 7-9, 1989: **8th International Symposium and Technical Exhibition on Electromagnetic Compatibility,** Zurich, Switzerland. Contact: Dr. T. Dvorak, ETH-Zentrum-IKT, CH-8092 Zurich, Switzerland, (1) 256-2790.

May 9-12, 1989: **Dresden Symposium on Electrostimulation,** Dresden, G.D.R. Contact: Dr. K.-J. Schulze, Medical Academy "Carl Gustav Carus," Dept. of Orthopedics, Fetscherstrasse 74, Dresden, 8019 G.D.R.

(The entire 1988 conference calendar appeared in our last issue.)

Brain Tumor Victim Sues HL&P

A Texas family whose land had been condemned for a power line right-of-way (ROW) by Houston Lighting & Power (HL&P) has sued the utility, alleging that the electromagnetic fields (EMFs) from the line caused one of them to develop a brain tumor.

HL&P bought an easement of more than half an acre from Beverly Scott Rainwater for $11,000 in 1980; there are three buildings on the remainder of the lot. Rainwater works in a house within 20 feet of the 345 kV power line. Her brother, Michael Scott, and his wife, Vicki, live in a house which is approximately 150 feet from the line. Their mother lives further away on the lot. HL&P energized the power line in 1983. In 1987, Michael Scott, then 26, developed an astrocytic brain tumor.

The 345 kV line first became the center of controversy when the Klein Independent School District sued HL&P for placing it across school property without proper permission. In 1985 a jury awarded the school district $25 million in punitive damages (see *MWN*, November/December 1985). Late last year, an appeals court reversed the award but affirmed the potential health issue – by that time, HL&P had moved the line at a cost of $8.6 million (see *MWN*, November/December 1987). The decision is being appealed.

In two suits filed on December 14, John McDowell, the attorney representing the family, charged that HL&P should have warned his clients about EMF health risks and also should have moved the line to reduce the family's exposure to EMFs, as it had done in the case of the Klein school. McDowell alleged that HL&P was negligent in its failure to warn the family, which was "inexcusable and reprehensible conduct." In addition, he argued that HL&P committed fraud by not disclosing – in the course of the original real estate transaction – the health risks.

In a telephone interview with *Microwave News*, McDowell said that documents released in the Klein case revealed that HL&P started collecting material on the health effects of power line EMFs in 1975, but had not made this information public. "Under Texas law," he said, "if you find out about a health risk, you have a duty to warn people about it."

In papers filed with the court on January 11, HL&P denied the allegations.

McDowell said that he does not expect the case to go to trial for at least 12 to 18 months.

BBC To Cover Power Lines

The British Broadcasting Company (BBC) is in the process of taping an hour-long documentary on the health effects of power line electromagnetic fields.

The documentary will be aired on the BBC's *Panorama* program – roughly the equivalent of the U.S.'s *MacNeil/Lehrer Report*. Tom Mangold, the show's correspondent, told *Microwave News* that the program will be broadcast on March 21. Paul Gibbs is the producer. It is not yet clear whether the documentary will be shown on American television.

EPRI Developments

Dr. Richard Balzhiser has been appointed the new president and chief executive officer of the Electric Power Research Institute (EPRI). Balzhiser has been with EPRI since 1973, most recently as executive vice president. Previously, he was the chairman of the department of chemical engineering at the University of Michigan in Ann Arbor.

Risk Analysis & Measurements

EPRI's electric and magnetic fields (EMFs) group is in the process of reviewing proposals for two new projects on risk analysis and on measurements:

- *Risk Management Frameworks:* The winning bidder on project No.RP2560-1 will assess the potential value of formal risk management methods in addressing EMF concerns and, where appropriate, will develop such frameworks. Proposals were due on December 4.
- *Measurement Project for Utilities:* The contractor for project No.RP2966-1 will organize and run workshops to train utility staffers in the collection and interpretation of EMF measurement data collected with the recently-developed EMDEX system. Proposals were due on December 15.

Revised Edition of the "Red Book"

EPRI has issued a revised version of the second edition of its *Transmission Line Reference Book: 345 kV and Above* (EL-2500), commonly known as the "red book." The 625-page volume features 13 chapters, written by a variety of experts and covering all aspects of high voltage power lines, including EMF effects, corona loss and radio and audio noise. The EMF effects chapter was written by Dr. Don Deno and L.E. Zaffanella, both of General Electric Co. A copy of the red book is available for $110.00 ($220.00 outside the U.S.) from: Research Reports Center, PO Box 50490, Palo Alto, CA 94303, (415) 965-4081.

Congressional Hearings Video

EPRI has prepared a 52-minute videotape of excerpts from the three-and-a-half-hour congressional subcommittee on water and power resources hearings held on October 6 (see *MWN*, September/October and November/December 1987). The tape is available in VHS, Beta and 3/4-inch formats for $50.00; order code: EA87-15. Contact: Susan Rapone, EPRI, PO Box 10412, Palo Alto, CA 94303.

Workplace ELF Exposures

A group led by Dr. Joseph Bowman of the University of Southern California (USC) School of Medicine in Los Angeles will soon publish measurement data indicating that "electrical workers" are exposed to extremely low frequency (ELF) magnetic fields that are "significantly above the levels encountered in residences and most offices."

In a paper which will appear in the May 1988 issue of *Applied Industrial Hygiene*, Bowman and coworkers conclude that these elevated workplace exposures lend support to the hypotheses generated by occupational leukemia studies. Many of these studies have found that electrical workers are at a greater risk of developing cancer (see, for example, *MWN*, March/April and May/June 1986). Very little information on the actual exposures of electrical workers has been available, however.

Among those exposed to the highest magnetic fields were: electricians working with industrial power supplies; underground and overhead power line workers; welders; and transmission station and distribution substation operators. The exposures varied considerably – some were above 100 mG, though most were between 10 and 50 mG. In comparison, residential exposures were normally below 1 mG.

The USC team found that elevated magnetic field exposures are not limited to the "electrical worker" job categories, but can also occur near such devices as battery-driven forklifts.

The difference between electric field exposures in workplaces and in residences tended to be lower than in magnetic fields due to the effective shielding provided by metallic electrical equipment.

In an interview with *Microwave News*, Bowman cautioned that his exposure estimates are preliminary and should be considered in the context of a "pilot" study. Bowman was recently awarded a contract by the Electric Power Research Institute (EPRI) to carry out more detailed occupational measurements – that study is just getting started (see *MWN*, July/August 1987).

Wertheimer and Leeper on Epi Study Pitfalls

Reprinted below is a memorandum from Dr. Nancy Wertheimer and Ed Leeper on "Possible Pitfalls in Interpretation of ELF Research." The memo is dated November 4, 1987.

Many "heresies" of our 1979 paper have now become almost commonplace: There is, today, fairly good acceptance for the importance of magnetic (not just electric) fields (MFs), and for the possibility that physiological effects may occur with milligauss fields; for the role played by ground-return currents in putting MFs out into the environment; for the validity of wiring configurations as an index of MF exposure; and for the relatively modest exposure from most appliance sources (as opposed to the 1979 consensus that the "25 gauss hairdryer" precluded any possibility of an effect from milligauss fields) – and so forth.

We feel our track record has been a decent one. And we hope that, on the strength of it, our further ideas on the subject will be seriously considered. Those ideas include the following:

1. *Little increase in cancer is to be expected among young children exposed prenatally to the most extreme sources* of chronic MF exposure. We have seen this pattern in our own data and in that of Fulton, Myers, Tomenius and Savitz. Moderate exposures before birth were, in each case, associated with increased cancer after birth; but extreme exposures, encountered prenatally, were not. Our hypothesis is that this pattern occurs because MFs can have an adverse effect on tissue development which, if it is severe and occurs in the first trimester of pregnancy, may often lead to prenatal abortion rather than to postnatal cancer.

2. *Little increase in cancer is to be expected in subjects who once lived at high-exposure homes, but who left those homes* more than two or three years prior to cancer diagnosis. (See Table 7 of our adult cancer paper, and the discussion of "onset age" in our 1979 paper. Note also that the Savitz study deals almost entirely with addresses occupied within three years preceding diagnosis.) And presumably a similar pattern may hold for occupational exposures.

3. *An increase in cancer rate may not be seen at all ages for a given type of cancer*. A discussion of this possibility is presented in some detail in our recently published paper, "Magnetic Fields and Cancer Subtypes" (*Annals of the New York Academy of Sciences, 502*, pp.43-54, 1987).

We have written this memo to urge those involved in epidemiological work on MF effects to try to explore the above ideas in their project planning and in their interpretation of results. Not all the ideas may prove valid, but there is a reasonable amount of evidence for them in existing data. And if they *are* valid, then not to include them in evaluating studies could lead to false negative conclusions, since each idea delineates an area where increased cancer risk may *not* occur with increased MF exposure, even if the hypothesis that MFs affect cancer proves to be true generally.

Congressional Questions on ELF Research

Following the October 6 hearing on the health effects of the extremely low frequency (ELF) electromagnetic fields (EMFs) associated with power lines, Congressman George Miller (D-CA), the chairman of the House subcommittee on water and power resources, asked the witnesses to follow up their testimony by supplying written answers to a number of detailed questions. Reprinted below are excerpts from some of those questions and answers. The complete exchanges will be published in the official hearing record, which is now at the printer and should be available in a couple of months. (See also MWN, *September/October and November/December 1987.)*

Dr. Ross Adey, VA Hospital, Loma Linda, CA

Q: When will the NCRP report on ELF to EPA come out?
A: We anticipate completion of the final draft in the spring of 1988. However, in accordance with NCRP procedures, review of this draft by the governing board is likely to take another year before publication.
Q: Please describe how the Department of Health and Human Services (HHS), in particular the NIEHS, has been involved in research on the biological effects of transmission lines. Have you ever tried to get funds from NIEHS or NIH?
A: I am not aware that any agency of HHS has ever been involved in significant support of any studies of possible health effects of power lines, either through support of individual projects or on a programmatic basis.

NIEHS has had a small program of intramural and extramural research, but this has dwindled in the last three years to an insignificant effort. The focus of intramural research at NIEHS was on reproductive abnormalities resulting from microwave exposure of birds' eggs. These studies were terminated two years ago and the laboratory closed. Studies of health effects of non-ionizing electromagnetic radiation (NIR) have held a low priority at NIEHS since their inception about 15 years ago, placing far greater emphasis on toxicology of environmental chemical pollutants. However, *NIEHS management has never considered the potential importance of joint actions of EM fields and chemical pollutants in cancer promotion and other health hazards....*

It has been the NIH custom to refer research proposals on NIR to radiology study sections with memberships composed almost exclusively of ionizing radiation biophysicists and physicians. In consequence, I and others are frequently requested to act as external reviewers on these proposals on an *ad hoc* basis. There is the presumption in this policy that there is no need for a separate study section to represent the constituency of researchers in NIR, or worse, that ionizing radiation scientists are inherently competent to examine these proposals. I submit that this is perilously close to malfeasance in public office. In essence, *we have grown contemptuous and frustrated by NIH policies to the point where it is recognized that no good purpose is served by submitting research proposals to NIH.*

The NCI sent a representative to several scientific meetings and symposia on bioelectromagnetics in 1985 and 1986. Personal discussions with him failed to elicit any indication that he grasped the significance of either the physics or the biology of these presentations. His own area of professional competence is restricted to ionizing radiation. It would not seem realistic to expect that his reports to NCI management would reflect a pervasive awareness of the scope and content of current knowledge.

Dr. Robert Becker, Becker Biomagnetics

Q: To do research adequately, a researcher needs upfront funding to finance research for approximately how many years?
A: The minimum number of years for which funding must be assured is three to four years....If the regulatory agencies or other branches of the federal government require that the mechanism of action of such fields upon the human be determined before any action is taken, much valuable time, as well as lives, will be lost. Speaking as a physician I believe that such information is not required to deal with this urgent health problem. I therefore recommend that two approaches be taken concurrently. One, that laboratory evidence linking such exposure to cancer and genetic abnormalities be expedited. ...Two, to link such fields with human diseases in the real world, large-scale epidemiological studies need to be performed. It is via this approach that one will be able to determine the actual level of such fields that is productive of harm....I further suggest that such studies be undertaken at the two ends of the electromagnetic spectrum currently in use, that is, at the 60 Hz power frequency and at microwave frequencies.
Q: Do you think that chronic exposure to ELF fields has an effect on progeny and birth weights?
A: I believe that the data obtained in my laboratory and published in 1975-76 indicated that chronic exposure to ELF fields results in decreased birth weight and survivability of progeny....I further believe that the extensive studies done at Battelle and funded by the DOE are supportive of my results....

Sheldon Meyers, EPA

Q: How was the public policy decision to cut out all funding for NIR made at EPA?
A: The purpose of the NIR research program at EPA was to provide scientifically credible data on health effects to support guidance to other federal agencies on matters regarding NIR. The agency's Science Advisory Board reviewed a report on the biological consequences of radiofrequency (RF) radiation completed in 1984, and concluded that the report provided a scientifically defensible basis for developing guidance for RF radiation. The agency then considered expanding its research program on the health effects of ELF radiation. However, when ELF was considered next to other emerging priorities, such as radon, indoor air, stratospheric ozone, and global warming, it was ultimately decided the NIR research program would have to be phased out in order to increase our activities in these other important areas.

Dr. Jerry Phillips, Cancer Therapy & Research Foundation

Q: How would you describe the current state of funding for ELF NIR studies?
A: A number of adjectives come to mind when asked to "describe the current state of funding for ELF NIR studies," including, but not limited to, pathetic, abominable, and disgraceful. Dr. Ross Adey and others, testifying at the October hearing, have already painted a dismal picture in which frustrated scientists must confront a decrease in DOE's ELF budget, near extinction of ONR's budget, and no appropriate programs at either NSF or NIH. It appears that the electric utility industry is now funding more ELF work than any federal agency, a situation which, because of that industry's proprietary interest in such research, should, if nothing else, cause the government to fund well-planned and well-directed ELF research at a level at least comparable to industry's. Furthermore, while the U.S. is generally a leader in world science, one now sees us taking a definite back seat in government commitment and funding to the much smaller country of Sweden in the area of NIR research....I and several of my colleagues have encountered reluctance on the part of those charged with reviewing NIH and NSF grant proposals to recommend funding research in the area of bioelectromagnetics....I would recommend committing to a ten-year ELF research program. Individual researchers applying for ELF program funds should, as is

done commonly now, submit proposals detailing three to five years of scientific study, recognizing that funded projects would be eligible for renewal as is done at the NIH or NSF.

Dr. Richard Phillips, EPA

Q: What would be an appropriate level of funding for the federal government and non-federal organizations to spend during the next five years to adequately research the health effects of non-ionizing radiation?

A: ...It is my opinion that it would require about $7-8 million a year for five years to adequately research the health effects of ELF radiation.

Q: Earlier this year, I understand you attended the electromagnetics meeting in Portland. How would you assess what was reported at the meeting? Do you think that non-ionizing radiation presents a serious health risk?

A: ...The results have shown the following: 1) There is an association between the incidence of cancer in humans and exposure to 60/50 Hz magnetic fields. 2) A number of mortality studies in the U. S. and in Europe have shown that the incidence of cancer is elevated above the general population level among workers in electrical and electronic occupations. Such workers are likely to encounter exposures to electric and magnetic fields at power frequencies, i.e. 60/50 Hz. 3) Exposure of laboratory animals to 60 Hz electric fields causes a phase delay in the circadian rhythm (daily biological rhythm) and a marked reduction in the normal nighttime increase in the level of melatonin, a hormone produced by the pineal gland located in the brain.... 4) Exposure to ELF radiation during a certain period of the circadian rhythm of laboratory animals reduces the effectiveness of drugs to relieve pain. 5) An increased incidence of fetal malformations has been reported in swine, rats, mice, chickens and humans exposed to ELF radiation. 6) Exposure of human cancer cells in vitro to 60 Hz EMFs increases their rate of growth. 7) Exposure of brain cells in vitro increases the efflux of calcium ions from brain cells at specific frequencies and amplitudes. 8) Exposure of cells in vitro activates protein production by DNA and may alter gene expression. The observed effects are frequency specific. 9) Exposure of cells in vitro activates the production of ornithine decarboxylase, an enzyme that may be important in cancer promotion.

...I have to conclude that exposure to ELF radiation can produce adverse biological effects. However, before one can state with any degree of confidence whether or not exposure is harmful to humans, and at what level and with what duration of exposure, we need to verify the effects that have been reported, quantify them in terms of exposure level and duration of exposure, and establish a basis for extrapolation of this data from animal studies and in vitro studies to the situation for humans....

Q: On September 16, 1986, you spoke in Toronto at a utility symposium on the health effects of EMFs. At that time, you said you wouldn't buy a home along a power line right-of-way (ROW). Do you still feel this way?

A: Yes. The reason for my answer at the Toronto meeting was based primarily on economics....If a causal relationship is established between exposure to magnetic fields and cancer, homes adjacent to ROWs of 230 kV or higher high-voltage power lines are very likely to show a marked depreciation in value. Accordingly, I would not buy a home on the edge of a ROW of a high-voltage power line. My answer to this question is still yes, not only for the economic concern I had at the time of the Toronto meeting, but because additional information that has come from more recent research indicates there may truly be a health hazard associated with chronic exposure to ELF radiation.

Robert Rabben, DOE

Q: [In a] memo provided by the Office of Energy Storage and Distribution to the subcommittee, it says, "In DOE's view, investigation of the potential for health hazards due to EMFs is in the public interest. While research has shown that there are probably few direct short-term effects, the possibility of cancer enhancement cannot, at this point, be totally excluded." In view of the above statement, why did DOE expect a decrease in funding for FY 1988?

A: We believe that sufficient funds were requested to continue examining the most important health issues.

Dr. Leonard Sagan, EPRI

Q: What sort of clearance process does a researcher receiving funds from EPRI have to go through before the researcher's results are published? Do EPRI-supported researchers have to agree to restraints on what they find?

A: Results of EPRI-funded work may be published as either EPRI reports or in the open scientific literature. Studies published as EPRI reports are edited by EPRI staff members for both readability as well as for scientific accuracy. There are no restraints on what EPRI-funded researchers may publish in the open literature. Our standard contract does request that a copy of manuscripts be provided us at least one month before submission. Normally the EPRI project manager would [review] a manuscript with the investigator and suggest changes if warranted. They are not mandatory, however.

Q: In 1979, Dr. Nancy Wertheimer found results which some considered startling. Why didn't EPRI agree to fund a repeat of the Wertheimer study to confirm or deny her findings?

A: EPRI was not asked to fund a repeat of the Wertheimer study. We chose not to take an initiative to repeat this work because the New York Power Lines Project undertook a replication, the results of which are now available. EPRI has initiated a study of childhood leukemia and its possible relation to EMFs in another city, Los Angeles. Still another study is now in our planning process.

Dr. David Savitz, University of North Carolina

Q: If there were no limits on funding, what studies would you recommend be supported?

A: The electric utility worker study that we are conducting and a similar study conducted by investigators in Canada and France constitute one important strategy for expanding knowledge of the effects of occupational exposure. More work might be done, but these studies seem sufficient in that realm.

The area which is being developed more slowly and is in great need of government funding is the study of residential EMF exposures and childhood cancers. If funding were available, the next study of this issue should: 1) Cover a geographic area (probably three to five large urban populations) of sufficient size to study newly diagnosed cases of leukemia, brain cancer, and possibly lymphomas, along with controls identified around the time of case diagnosis; 2) Use a coordinated exposure assessment protocol based on wiring and in-home measurements. This is not radically different from our study or the ongoing Los Angeles study, but the study size would be notably advantageous, and by fine-tuning the methods based on past experience, a superior study would result.

It might also be noted that studies of this type are very difficult for independent investigators to develop because of their expense and logistical complexity. I would estimate that this study would cost at least $2-3 million. The NCI has a tradition of noting suggestive findings and embarking on the most definitive study possible to confirm or refute those suggestions. An excellent example is the national bladder cancer study designed to address concerns with artificial sweeteners. I participated in a multi-center study of invasive cervical cancer with similar goals of addressing suggestive literature with more definitive information. Thus, I would be most supportive of the NCI developing (ideally with the collaboration of outside investigators) such a multi-center study of residential magnetic field exposures from power lines and childhood leukemia, cancer and lymphoma.

U.S.A.F. Investigations of Radiation Incidents

At least ten times from June 1984 to June 1986, the U.S. Air Force (USAF) has investigated actual or possible overexposures of personnel to radiofrequency (RF) radiation. According to documents obtained by *Microwave News* under the Freedom of Information Act, officials at the Occupational and Environmental Health Laboratory (OEHL) at Brooks Air Force Base (AFB), TX, have confirmed partial or whole-body exposures above the USAF's permissible exposure limits (PEL) in five of the incidents. The USAF's frequency-dependent PEL is keyed to a specific absorption rate (SAR) of 0.4 W/Kg over a six-minute period.

The following summaries of the ten incidents are based on OEHL's reports. Copies may be obtained from: OEHL, Aerospace Medical Division, Brooks AFB, TX 78235. Refer to the report numbers that appear at the end of the summaries.

• On September 14, 1983, six workers were exposed to 420 MHz fields possibly as strong as 390 mW/cm² at Clear USAF Station, AK, when a technician accidentally switched on a high-power AN/FPS-92 tracking radar while the men were performing maintenance work (see *MWN*, November 1983, January/February and December 1984 and November/December 1985). OEHL conducted an RF radiation hazard survey at Clear on April 28, 1985, at the request of FELEC Services, Inc., the USAF's contractor for the facility. Though the survey report included no data that pertains directly to the accident, it concluded that the AN/FPS-92 radar "cannot be operated when personnel are in the radome," where the men had been working. The OEHL survey measured a maximum field of 3 mW/cm² from the AN/FPS-92 on the rooftop of a building 700 feet from the transmitter. Fields atop the roofs of scanner buildings located in front of AN/FPS-50 Detector Radars ranged from 5 to 30 mW/cm², and the USAF concluded that personnel should be prohibited from entering these areas during radar operation.
(Report No.85-105RN998FRA)

• On June 12, 1984, while installing an antenna on top of a TRC-87B radio van in 90-degree weather, an air national guardsman with the 103rd Tactical Control Squadron in Orange, CT, reported feeling hot. At one point the airman, Donald Wilson, inadvertently bumped against a support at the base of the antenna, which he said "felt like he had touched a hot car seat," and he immediately withdrew his arm. OEHL investigators later estimated that the contact lasted no longer than two seconds. Wilson's supervisor noticed the airman was sweating and told him to come down. The entire incident lasted 10-15 minutes, according to the investigators, who recreated it on February 4, 1985. They could not determine whether the system was transmitting during the incident, but the TRC-87B antenna, which runs at 259.4 MHz, was set to operate at 10 watts. The doctor who examined Wilson immediately after the incident observed a "mild" second-degree burn on part of one arm and first-degree burns on both arms. He "presumed" that the more severe burn resulted from RF exposure, according to the OEHL report. Two days later, Wilson reported nausea, diarrhea and cold, clammy skin after working outdoors. Officials supervising the recreation concluded that the airman "definitely was not overexposed" to RF radiation and that his second-degree burn was sunburn, aggravated by contact with the hot metal antenna support. Wilson may have been exposed to approximately 90 mW-s/cm² at his head, hands and torso and to approximately 1 mW-s/cm² at his upper arm, where the second-degree burn occurred. The PEL for the system's frequency is 2.59 mW/cm². Wilson's other symptoms were diagnosed as heat exhaustion.
(Report No.85-066RN491CRA)

• On September 1, 1984, two radio technicians for the Air National Guard in Savannah, GA, were attempting to fix a power amplifier problem inside a 775 MHz electrical equipment shelter (equipped with an MRC-113(V)2 open waveguide 283 CCS ANG) when they noticed that a waveguide collar connector and clamps had not been secured in a previous maintenance adjustment. In a test, the workers measured what they thought was a significant level of RF leakage into the shelter. That evening, TSgt. Ian Carson, who had been working near the shelter door, felt tingling in his hands, and as of February 1985, the date of OEHL's report, he continued to suffer intermittently from hand- and finger-joint pain. Investigators who reconstructed the event in December 1984 concluded that the worker was exposed to a maximum of 57 and 90 mW/cm² in his left and right hand-wrist areas, respectively. While finding that Carson had been overexposed – the applicable PEL is 7.75 mW/cm² – the OEHL report offered no clear explanation for his ailment, but concluded that induced current was not the cause. The second worker did not report adverse effects, and the USAF concluded that he had not been overexposed. Although not noted in the text of the report, Carson complained (in an attached statement) of suffering from previously non-existent high blood pressure. The USAF recommended further medical evaluation and suggested that technicians conduct RF radiation surveys of waveguide junctions at the end of all maintenance activities.
(Report No.85-051RN406BRA)

• On January 23, 1985, Senior Airman Richard Russell, a ground crew member at Bergstrom AFB, TX, was overexposed to RF radiation while inspecting an AN/ALQ-119 electronic countermeasures (ECM) pod of an F-4 jet. Russell felt heat intermittently from his knees to his chest during the procedure. After reporting the problem, Russell was examined for possible symptoms of RF overexposure. The AN/ALQ-119 ECM pod is a jamming device used to protect the fighter jet in flight. In the reenactment of the incident – which took place at Eglin AFB, FL, due to concerns for EMI – an investigator also felt the heat sensation. OEHL estimated that the average power density levels ranged from 5.7 mW/cm² at Russell's head to 147.5 mW/cm² at his hands; his chest, groin and knees were also overexposed. The system's operating frequency is classified, but the stated PEL for 1-300 GHz is 10 mW/cm².
(Report No.85-113RN017GRA)

• On February 1, 1985, a Cannon AFB, NM, technician was troubleshooting an APM-358 Microwave Signal Source Test Set Drawer for a possible microwave leak when he felt a warm sensation in his left hand. After the technician shut the system down, a cracked waveguide connector was discovered – but the USAF did not promptly investigate or examine the technician, Airman First Class Mark Innis. Only when a macule (blemish) appeared on Innis's hand five days after the incident did he undergo medical care. The drawer's output signal is between 15.7 and 16.9 GHz at 100-150 milliwatts, mitigated by a 3 dB attenuator. OEHL concluded that, "Innis's sensation of warmth in his hand is consistent with the frequency range to which he could have been exposed." Though OEHL could not recreate the incident because the defective waveguide had been replaced, investigators estimated that the technician's whole-body exposure

was no more than 5.3 mW/cm², compared to a PEL of 10 mW/cm². Officials reported that his heat sensation could be attributed to the exposure but, because no burn occurred within 24 hours of the incident, they concluded, "It is difficult but not totally impossible to link the seemingly coincidental development of a transient macule to the exposure incident." They decided that no medical follow-up exam was necessary because there was no overexposure, and they recommended that personnel adhere to safety guidelines.
(Report No.85-079RN028DRA)

• A technician at the McGhee-Tyson Airport in Knoxville, TN, was overexposed to RF radiation while conducting power amplifier performance checks on a 4.4-5 GHz AN/TRC-97A transportable communications system. On four or five nonconsecutive days between March 5 and April 3, 1985, the technician, TSgt. Larry Roberts, conducted three or four 10-15-minute power checks per day. The discovery of a defective waveguide on April 3 prompted an investigation. OEHL found that the 1,000 watt power amplifier source was reflecting as much as 300 watts two feet away, where Roberts was working. In the "worst case" scenario, OEHL calculated that Roberts was exposed to 26 mW/cm² each time he ran a performance check. The PEL at the amplifier frequency is 10 mW/cm². According to the report, RF radiation exposure effects "are not considered to be cumulative," and therefore, each exposure was considered independent. The OEHL's report did not say whether Roberts felt ill at any time, and though he underwent a medical exam, the results of that exam were not included in the report, which was released two months after the OEHL investigation. "Receipt of a completed medical evaluation...has been delayed for a number of unavoidable reasons," the report explained.
(Report No.85-104RN332FRA)

• A civilian worker painting part of the containment of a phased array radar at Eglin AFB, FL, reported feeling flushed and dizzy and suffering from headaches and "chest pressure" in June 1985. Mark Stewart had twice previously painted the containment without falling ill. All three work periods were between June 10 and June 21. The AN/FPS-85 Radar operates at 400-500 MHz, but the precise frequency is classified. OEHL investigators found that Stewart was not overexposed: although fields in the areas where Stewart might have been were as high as 12 mW/cm², the OEHL concluded that he came no closer than four feet to an active radar element and thus, most likely, was exposed to fields on the order of 0.5 mW/cm², compared to a PEL of 4-5 mW/cm². The USAF recommended that all areas of array faces "should be considered as potentially hazardous." No medical evaluations beyond the initial examination immediately following the incident were deemed warranted. Investigators noted that fields on the ground in front of the radar "greatly exceeded" the USAF safety standard and specified that these areas, which are fenced off, should be marked with radiation warning signs.
(Report No.85-148RA058HRA)

• On September 10, 1985, two airmen at Myrtle Beach AFB, SC, were overexposed to RF radiation while performing a maintenance procedure on a QRC 80-01. The device is a modified AN/ALQ-119 electronic counter measures (ECM) pod, operating in several frequency bands, all greater than 1 GHz. While repairing the device, Airmen First Class Gary Deeds and James Bell were unable to complete a mid-band balance test – they repeated the 5-10-minute procedure four times. After both men felt heat coming from the system, their instructors noticed that the QRC 80-01's dummy load was missing, indicating unintended emissions. According to the report, Deeds was anxious about having been exposed, but felt nervous about the possible repercussions of reporting the incident. He suffered "flu-like" symptoms, such as headaches and general weakness, but returned to duty after a medical examination. Measurements taken during the OEHL's investigation suggested exposures ranging from less than 0.05 mW/cm² at the airmen's heads and below their waists to 90 mW/cm² at their hands; their abdomens and waists were exposed to 30 and 50 mW/cm², respectively. Deeds was exposed four times during the incident, while Bell was exposed at least once. The PEL above 1 GHz is 10 mW/cm². According to the OEHL report, "The exposure to the hands was the only one to have been at what could be called biologically meaningful levels." The report also cited the conclusion of a medical advisor (not the doctor who examined Deeds): "The only biological response which would be expected is the perception of heat which did take place. I do not consider the 'flu-like' symptoms related to exposure – it is not a known effect." He suggested that stress, rather than RF exposure, caused the symptoms and recommended against medical follow-up.
(Report No.85-179RN137KRA)

• Three civilian workers experienced a combination of cramps, headaches, nausea and soreness after doing routine maintenance on the AN/DPS-5 Tethered Aerostat Radar System (TARS) at the Cudjoe Key USAF Station in Florida. TARS is a USAF balloon-borne surveillance radar, which operates at 3.22 GHz with a peak power of 1236 kW. One of the three men worked on TARS on April 1, 1986, and the two others worked on the system two days later. All were employed by RCA, which maintains the radar system. Billy Fortner, the worker who serviced TARS on April 1, suspected RF radiation "spill-over" and later reported cramps and soreness. Paul Williamson and Charles Lafferty, who performed power output adjustments on the radar for about 15 minutes on April 3, later reported headaches, nausea and midsection soreness. All three men were sent to a civilian hospital, which "did not differentiate between nuclear and RF radiation and therefore conducted some unnecessary procedures," according to the OEHL report. OEHL determined that none of the men were exposed to radiation levels above 1 mW/cm², compared to a PEL for occupational exposure of 10 mW/cm², and concluded that there could not have been overexposure because the men did not experience heat sensations or reddening of the skin while working. OEHL also found that Fortner's symptoms were not associated with microwave radiation because they started 20 hours after the incident and that Williamson and Lafferty, who began feeling sick within 15 minutes of the incident, probably suffered heat stress and motion sickness (the TARS radar unit rotated). The USAF recommended against further medical follow-up for the workers, but urged that an RF hazard training program be set up.
(Report No.86-044RN0088FRA)

• On June 12, 1986, two men were exposed to 0.1 mW/cm² of 4950 MHz radiation from an AN/MST-TIA (MUTES) scoring radar while painting an air conditioner on the roof of a nearby building at La Junta, CO. Airman First Class Ted Leach, the first man to be exposed, had hung warning signs on two TLQ-11 radars housed in the building where he was painting but did not post a sign on the MUTES. After 45 minutes of painting, Airman First Class Kevin Coleman relieved him. Leach then noticed flashing lights on the MUTES, indicating that it was transmitting. Coleman was exposed for no more than 10 minutes, according to OEHL investigators. In measuring radiation levels on the roof, the investigators found that neither worker was exposed to fields in excess of 0.1 mW/cm², although fields as strong as 10 mW/cm² were measured in accessible areas. The PEL at 4950 MHz is 10 mW/cm². OEHL's report concluded that written safety procedures are sufficient to control roof traffic and to prevent future exposures. The investigators found no medical evidence of overexposure and recommended against medical follow-up.
(Report No.86-070RN0063HRA)

UPDATES

BIOLOGICAL EFFECTS

Schwan Lecture... In 1986, Dr. Herman Schwan, professor emeritus at the University of Pennsylvania, delivered the Lauriston S. Taylor Lecture at the annual meeting of the National Council on Radiation Protection and Measurements (NCRP). The NCRP has now published Schwan's talk, *Biological Effects of Non-Ionizing Radiations: Cellular Properties and Interactions* (Lecture No.10), in booklet form. It is available for $12.00 from: NCRP Publications, 7910 Woodmont Ave., Suite 1016, Bethesda, MD 20814, (301) 657-2652. The lecture will also be published as part of the proceedings of the NCRP's 1986 meeting.

Bioeffects Critique... The U.S. Air Force has released a *Critique of the Literature on Bioeffects of Radiofrequency Radiation: A Comprehensive Review Pertinent to Air Force Operations* (USAFSAM-TR-87-3), by Louis Heynick, who recently retired from SRI International. The 691-page review covers non-ionizing radiation effects in the 10 kHz-300 GHz frequency range and was commissioned as a reference source for environmental impact statements on radiation-emitting USAF systems; it features more than 600 references. For more information, contact: James Merritt, USAF School of Aerospace Medicine, Human Systems Division, Brooks AFB, TX 78235, (512) 536-3583.

COMPATIBILITY & INTERFERENCE

ESD Suspected in MX Explosion... Plaintiffs in a lawsuit filed last September, which alleges that the armed forces have not adequately addressed the issues of hazards of electromagnetic radiation to ordnance (HERO), have asked the Pentagon to produce reports on a recent MX missile fire which killed five technicians (see *MWN*, September/October 1987). The explosion occurred while fuel was being loaded into the first stage of an MX missile at a Morton Thiokol plant in Utah on December 29. Although company officials have not specified the cause of the accident, the plaintiffs suspect that electrostatic discharge (ESD) was to blame. The lawsuit, now in pretrial discovery, also seeks data on more than 50 weapons systems accidents – including six other solid fuel explosions and some of the recent UH-60 Black Hawk Army helicopter crashes (see *MWN*, November/December 1987). In court papers, the plaintiffs – whose number has grown from four to 39 and now includes Physicians for Social Responsibility – allege that there are similarities between the MX accident and a 1985 Pershing II missile explosion in West Germany (see *MWN*, June 1985).

Assorted Notes... In our September/October 1987 issue, we featured a report on the efforts of NBS's François Martzloff to control conducted EMI. For more on this, see Ivars Peterson's article, "In Search of Electrical Surges," in the December 12 *Science News*....The Microwave Filter Co. has issued *The Filter Book*, which covers the company's products in the 1 MHz to 26 GHz frequency range. Copies are available from: Microwave Filter Co., 6743 Kinne St., East Syracuse, NY 13057, (800) 448-1666, or (315) 437-3953 in NY....Two Texas Instruments Inc. researchers have published "Characterization of Metals as EMC Shields" in the September 1987 *IEEE Transactions on Instrumentation and Measurement*.... Comsearch Applied Technology, Inc. of Reston, VA, has won a $5.6 million contract from the Naval Surface Warfare Center in Dahlgren, VA, for below-deck EMI services....In our last issue, we noted the conflict between British radio astronomers and broadcasters over limited frequency space. Now, according to the December 24/31 *New Scientist*, the potential interference problem appears to have been resolved by reallocating spectrum space given to air traffic controllers; broadcasters can now hope for a fifth television channel by 1991, leaving astronomers free to detect pulsars without EMI.

GOVERNMENT

FCC on FM Boosters... The FCC has proposed adding FM booster stations to its list of facilities that must comply with its RF radiation health regulations. The move was prompted by July 1987 FCC rules that lifted the previous 10-watt limit on output power. Now, FM boosters can be much more powerful – up to 20% of the maximum permissible ERP of the primary station. In 1985, the FCC issued regulations requiring applicants for its licenses to either meet the ANSI RF/MW radiation safety standard or complete an environmental impact statement (see *MWN*, April 1985 and March/April 1987). Comments were due by February 8, with reply comments due by February 23. For more information, contact: Dr. Robert Cleveland at the FCC's Office of Engineering and Technology, (202) 653-8169.

...and on Satcom Stations... On December 30, the FCC issued a public notice (No. DS-703) reminding all applicants for transmitting earth stations that they must "include a statement that the station is in compliance with the environmental radiation health standards" codified in the commission's regulations. Those not in compliance must submit an environmental assessment.

MEASUREMENT

Magnetic Field Meter... Electro-Metrics has introduced a new meter that can measure low-level magnetic fields. The MFM-11 unit has a minimum sensitivity level of 1 nT from 20 Hz to 50 kHz – users can select any one of a large number of frequency bands within this range. In addition, filters are available to screen out power line noise. The unit costs $6,995 and is designed primarily for TEMPEST and EMC applications. For more information, contact: Paul Sikora, Marketing Manager, Electro-Metrics, 100 Church St., Amsterdam, NY 12010, (518) 843-2600.

MEETINGS

Hanford ELF Symposium...In October 1984, DOE, EPRI and Battelle Pacific Northwest Labs sponsored the 23rd Hanford Life Sciences Symposium on the *Interaction of Biological Systems with Static and ELF Electric and Magnetic Fields* in Richland, WA, home of the Battelle Labs. The proceedings of the meeting are now available. Because of the long delay in publication, many of the papers are no longer current. Nevertheless some of them are still useful and among these are: Dr. Hans-Arne Hannson's (of Sweden) observations of "lamellar bodies" in cerebral tissue of exposed animals. Dr. Gregory Lotz and Jack Saxton's (both of the Naval Aerospace Medical Research Lab in Pensacola, FL) second study of monkeys chronically exposed to ELF fields (see *MWN*, September 1984), designed to simulate the U.S. Navy's submarine communications system, which operates between 72 Hz and 80 Hz. Lotz and Saxton also reviewed the lab's first monkey study – a final report on that experiment was never published. Also of particular interest is Dr. Don Deno's (of GE) discussion of exposures to weak electric and magnetic fields in the home. In all, there are more than 40 papers by researchers from around the world. A copy of the 553-page paperback volume is available for $25.00 from: Dr. Larry Anderson, Battelle Pacific Northwest Labs, PO Box 999, Richland, WA 99352, (509) 375-2294.

Israeli Meeting Canceled...The *International Symposium on Interaction of Electromagnetic Fields with Biological Systems*, which was scheduled to be held this March in Israel, has been canceled "due to lack of interest" (see *MWN*, November/December 1987).

MILITARY SYSTEMS

Microwave Weapons...If you want to know what a microwave weapon looks like, open the December 7, 1987 issue of *Aviation Week* to page 85 for a picture of the U.S. Air Force's "Gypsy microwave device," which is being used to test the susceptibility of electronics systems. The Gypsy device can produce more than one *gigawatt* of power in short pulses and is tunable over the frequency range 800 MHz to 40 GHz. The Air Force program is based at Kirtland Air Force Base, NM, where a conference on high-power microwave (HPM) technology was held in December 1986 (see *MWN*, January/February 1987)....According to the May 4, 1987 *Aviation Week*, the HPM effort sponsored by the Defense Nuclear Agency (DNA), the U.S. Air Force and the U.S. Navy has a budget of $15 million in fiscal year (FY) 1988....Some of that money will go to the company that successfully responds to a DNA request for proposals (RFP No.DNA001-88-R-0009, issued on November 25) for 45 months worth of studies on the effects of HPMs on weapons systems, on methods to protect such systems and on the feasibility of propagating HPMs through the atmosphere. Among the options listed in the RFP are experiments designed to "determine the maximum microwave power density...that can be propagated through the atmosphere before air breakdown occurs" and tests to determine the HPM susceptibility of orbital satellites. The winning contractor will need a top secret security clearance....The Lawrence Livermore National Lab (LLNL) and the Sandia National Lab are also working to assess the vulnerability of electronics to HPMs. There is a short article on the program in the July 1987 issue of *Energy and Technology Review*, published by LLNL....And in its March 1987 issue, the magazine featured a longer item on LLNL's research on HPMs and pulsed power....Dr. James Benford of Physics International in San Leandro, CA, reviews "High Power Microwave Simulator Development" in an article appearing in the December 1987 issue of the *Microwave Journal*....The U.S. Army has its own product – a radiofrequency (RF) weapon. In the August 24, 1987 *Defense News*, John Rosado of the Harry Diamond Labs in Adelphi, MD, is quoted as saying that "the nature of warfare will be completely changed by the use of [RF] weapons." Rosado also noted that RF radiation could be used over a wide battlefield with phased arrays....Some of the DOD's concern over RF and HPM weapons is reflected in a recent glossy pamphlet, *The Soviet Space Challenge* (issued in November 1987), in which the DOD notes that, "The Soviets could test a ground-based [RF] weapon capable of damaging satellites in the 1990s."...Watch for the review of "Tactical Microwave Weapons" by Dr. H. Keith Florig of Carnegie-Mellon University in the March 1988 issue of *IEEE Spectrum*.

OVENS

CU Ratings and Warning...In its January 1988 issue, *Consumer Reports* rates microwave ovens. At the top of the list are units by Litton, GE, Whirlpool and KitchenAid, with prices ranging from $328 to $385. As for safety, Consumers Union (CU) found that all the ovens tested were "well within" the FDA's leakage standard and notes that, "A door seal on all recent models minimizes leakage even when slight gaps develop between the door and the oven."...In its February 1988 issue, CU issues a warning concerning what appears to be the use of scare tactics to sell an oven radiation meter. CU cites an ad by American Health Products of Houston, TX, which quotes the bulletin of the "National Microwave Safety Council" as urging that all ovens be immediately checked for leaks and which also quotes *Business Week* as warning that CU found many leaking ovens. The trouble is that the CU quote is 15 years old, and CU could find no trace of the council. And the Houston outfit, which sells its meter for $29.95 is not listed in the Houston telephone book. The FDA is now trying to track down both the Houston company and the council – so far, without success.

Assorted Notes...The sales of microwave ovens continue to shatter all records. The Association of Home Appliance

Manufacturers, based in Chicago, IL, reports that more than a quarter of *all* appliances shipped in 1987 were microwave ovens – the largest annual shipment of any major appliance in history....On a more somber note, three physicians from the University of Iowa in Iowa City describe two cases in which infants suffered burns from microwave ovens. "Microwave Oven Burns to Children: An Unusual Manifestation of Child Abuse" appears in *Pediatrics*, *79*, pp.255-260, 1987.

PEOPLE

Sheldon Meyers, director of the EPA's Office of Radiation Programs since August 1984, is leaving his post to become the agency's associate administrator for international activities. **Richard Guimond,** the head of the EPA's radon division, is taking over for Meyers....**Thomas Keller** has been appointed chief scientist at the National Association of Broadcasters (NAB). Keller will work out of the NAB's new Broadcast Technology Center, which seeks to encourage the development of high-definition television. **Michael Rau,** a staff engineer, is taking over many of Keller's former duties. Rau has been named a vice president and the acting head of the NAB's Science and Technology Department....**Jules Cohen** will receive the NAB's Engineering Achievement Award at this year's convention in Las Vegas on April 9. Cohen is the president of Jules Cohen & Associates, a consulting firm in Washington, DC....Dr. **Forrest Lee Carter** of the Naval Research Lab in Washington, DC, died of cancer on December 20. Among Carter's many interests were the emerging fields of molecular electronics and solitons....The Bioelectromagnetics Society (BEMS) has decided not to present its D'Arsonval Award this year. The prize is given in recognition of outstanding research achievement. (Sources say that the BEMS board was divided between two candidates.)

ETC...

Radio Radio Everywhere... Anne Scully lives in Hull, MA, near WBZ's 50 kW transmitter, and she can pick up the station from her radiator and from her telephone. She told *The New York Times* (January 17) that her neighbors can pick up WBZ from their microwave ovens and their toilets. NPR's *All Things Considered* also aired a light-hearted piece on Mrs. Scully's troubles the same week.

McFarland Cancer Cluster *(continued from p.1)*

compatibility consulting firm in Los Angeles, told *Microwave News* that, although he had not made any measurements in McFarland, he thinks that a "substantial" field would impinge on a town as close to the VOA transmitter as McFarland. The engineer, who has nearly fifty years of experience in electromagnetic field measurements – much of it in southern California, said that he has received numerous inquiries about the possible impact of the VOA radiation on McFarland. "It is far more significant than parts-per-million chemicals," he said. The engineer asked that his name not be used.

Other experts have raised the possibility that some kind of synergy between toxic chemicals and non-ionizing radiation may be at work in McFarland. Laboratory studies indicate that microwaves can enhance the carcinogenicity of benzopyrene and the teratogenicity of cytosine arabinoside (see *MWN*, May 1981 and January/February 1987). Microwaves can also act synergistically with drugs (see *MWN*, February 1981).

Indeed, new experimental evidence points to the efficacy of the combined action of RF radiation and chemicals. Adey explained that, "Work in our laboratory by Dr. William Fletcher has shown that weak modulated RF fields can significantly enhance chemical cancer promoters. Together they disrupt communications between cells through gap junctions. These findings are consistent with modern cancer models, which emphasize that this type of disruption leads to unregulated cell growth."

In addition, some of those interviewed said that the intermittent nature of the VOA broadcasts could pose a greater health risk than constant exposures, because on-and-off stimuli prevent biological systems from adapting.

Since 1975, at least 12 children have developed cancer in McFarland, which has a population of approximately 6,000. Six of the children have died. Eight of the cases were diagnosed in the 1982-1985 time period, which constitutes a much rarer cluster. Two of the cases were identified before 1982 and two after 1985.

Many different types of cancer have been diagnosed among the McFarland children, including leukemia and brain and kidney cancer.

In a telephone interview from McFarland, Connie Rosales, a mother of one of the cancer victims, said that she thinks at least two additional cases should be counted as part of the cluster. In addition, as we go to press in early February, there are news reports of the diagnosis of the 13th childhood cancer case in McFarland – a seven-year-old with a brain tumor.

According to Dr. Matthew Zack of the Chronic Disease Control Division at the Centers for Disease Control in Atlanta, GA, cancer clusters occur "fairly frequently," but eight cases in four years is "exceptional." Zack is a member of the newly-established McFarland Advisory Committee, chaired by Dr. Kenneth Kizer, the head of the California health department.

In addition to the cancer cluster, McFarland had "relatively high rates" of infant deaths in 1982-1983 and of fetal deaths and low birth weights in 1981-1983.

Because of the grouping of cancer cases in 1982-1985, ESSS officials, who wrote the new report, placed particular emphasis on the period from January 1980 to January 1982 as the time when McFarland would most likely have been exposed to a toxic agent. They call this period the "window of vulnerability." McFarland's Rosales said she is skeptical about the window theory. A previous study by the county failed to identify any cause for the cluster based on then existing (1986)

conditions.

In numerous interviews with *Microwave News*, ESSS officials said that they had been advised by the VOA and by the Environmental Protection Agency (EPA) that the non-ionizing radiation levels in McFarland were "well below all existing standards." The ESSS report states that the EPA reviewed the VOA data and concluded that "any adverse health effects" in McFarland citizens were "unlikely to be related to RF radiation." ESSS adds, "We agree with this conclusion."

ESSS staffers are also skeptical about a possible link between VOA radiation and the cluster because they have been unable to document any changes in broadcasting from the Delano station during 1980-1983.

The state report also finds that it was unlikely that water contamination by nitrates and arsenic triggered the cancers. After reviewing existing records of pesticide use, the study found nothing abnormal in the types or amounts of pesticides applied in McFarland. "What we saw were commonly used pesticides in usual amounts," the report concludes. Nevertheless, four pesticides – dimethoate, fenbutatin oxide, dinoseb and dinitrophenol – have been targeted for further study.

The only partially suggestive finding in the state study is that 80 percent of the fathers of the cancer cases, compared to 45 percent of the fathers in a control group, worked in the crop fields in the time interval between three months before pregnancy and the date of diagnosis of the child's cancer. According to the report, "This is of borderline significance." The state plans to study this finding further in the next phase of its investigation.

Only one set of RF measurements has ever been carried out in McFarland. On February 6, 1986, a team of VOA engineers measured a level of 10 $\mu W/cm^2$ under a local power line and concluded that, "This implies that any health problems encountered in McFarland city were not directly linked to the VOA facility in Delano."

One of the engineers who took the measurements in McFarland and who no longer works at the VOA, told *Microwave News* that all their measurements were keyed to the levels specified in the 1982 American National Standards Institute (ANSI) standard: "We did not expect to find anything and we didn't."

The VOA did begin negotiations with the EPA to measure RF radiation levels at Delano and at other VOA stations. Due to lack of funds, however, no interagency agreement was ever completed and no additional measurements were taken.

Many non-ionizing radiation bioeffects experts agree that more detailed measurements are needed. In a telephone interview, Dr. Sam Milham of the Washington state Department of Social and Health Services said that, "It would be a good idea to do some measurements." Milham recently published a study showing that amateur radio operators have an increased rate of cancer mortality (see *MWN*, November/December 1987).

At the first meeting of the new advisory committee on January 29 in McFarland, a Kern County resident raised the issue of the need for more non-ionizing radiation measurements. At this time, the state has made no commitment to additional radiation measurements.

Very few studies of low-level exposures have ever been completed. In one landmark study carried out at the University of Washington in Seattle, rats exposed for their lifetime to the equivalent of the levels allowed by the ANSI standard showed a statistically significant increase in cancer (see *MWN*, July/August 1984 and March 1985).

In 1986, a group of Italian researchers showed that rats exposed to RF levels that were 4,000 times below the ANSI guidelines experienced developmental ill effects (see *MWN*, November/December 1986).

Until recently, the proposition that low levels of non-ionizing radiation could be biologically active or play a role in the development of cancer has been dismissed. In the last two years, however, a large body of evidence has accumulated indicating that extremely small (50/60 Hz) power line magnetic fields – as low as 2-3 mG – may promote cancer (see *MWN*, November/December 1987). The California study did investigate the distribution of power lines in McFarland but found no "significant changes" during 1980-1982.

The emerging link between a cancer risk and magnetic field exposures may be important in McFarland. Engineers explain that at shortwave frequencies, the ground-level magnetic field is stronger than the electric field component. Indeed, the VOA's own 1986 field survey at the Delano station shows that the measured magnetic field at 1,535 feet from one of the antennas was often greater than at 935 feet.

Also, last year, a preliminary epidemiological study by the Hawaii Department of Health indicated that people living near broadcast radio and television stations had a statistically significant higher rate of cancer than those whose homes were not near broadcast towers (see *MWN*, May/June 1987). In addition, the Cancer Research Center in Hawaii has identified a leukemia cluster among children living near a U.S. Navy communications complex at Lualualei on the island of Oahu (see *MWN*, May/June 1987).

A retrospective and an ongoing prospective epidemiological study of members of the Polish military exposed to RF and microwave radiation indicate a threefold increased risk of developing cancer; for some types of cancer, the risk is seven times greater than for controls (see *MWN*, March 1985 and JanuaryFebruary 1987).

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: Sarah Verdone; Contributing Editor: Mark A. Pinsky; Intern: Rachel Dean • Subscriptions: $250 per year ($285 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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MICRO WAVE NEWS

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New Listings

NCI Set To Begin Childhood Cancer-EMF Study

Role of NCI Scientists Questioned

The National Cancer Institute's (NCI) study of the possible association between childhood leukemia and electromagnetic fields (EMFs) is scheduled to begin in the fall. The four-year study, which will be part of a larger effort to understand the causes of childhood leukemia, will assess residential exposures from power lines and appliances.

In December, NCI announced that requests for proposals (RFPs) would be issued by the end of the month. They were not available by February 1, however, but an NCI spokeswoman said that they would be released very soon (see box on p.15 for a description of the study). The estimated cost of the EMF study is $2.5 million. NCI anticipates that awards will made by September 30, 1989.

The announcement comes as a storm is brewing over possible ethics violations by NCI staff members who have testified on behalf of utilities that there is no evidence of adverse biological effects from exposure to power frequency EMFs. Questions have also been raised as to whether such testimony might prejudice the NCI study.

"I think we have a very open mind going into this study," Dr. Martha Linet told *Microwave News*. Linet, the co-director of the NCI study along with Dr. John Boice, added that she had been unaware of her colleagues' testimony.

Last year, Drs. Stuart Aaronson, Lucius Sinks and Margaret Tucker, all

(continued on p.15)

Vernon Down's Syndrome Study Is Abandoned; Critics Voice Outrage

The New Jersey Department of Health (NJDOH) has dropped its study of the incidence of Down's Syndrome and other birth defects among babies born in Vernon Township, NJ, primarily because of the lack of evidence of a continuing problem and the "apparent impossibility" of estimating past microwave exposures.

Many observers contest both of these arguments. A leader of the citizens' group, Citizens Against the Towers (CAT), which first prompted the study, said that NJDOH's action "borders on criminal neglect. It's one big cover-up." CAT has long maintained that the large number of uplink antennas at three satellite complexes in the town may be in some way responsible for the health problems in the community.

(continued on p.14)

HIGHLIGHTS

Epidemiology Roundup

Support for Radio Operator Cancer Risk

Dr. Samuel Milham, Jr., has uncovered new evidence to support his epidemiological study which found that amateur radio operators had a significant excess mortality rate due to acute myeloid leukemia, multiple myeloma and certain types of malignant lymphoma. The original study, published last year, was based on data compiled by the Federal Communications Commission (FCC) (see *MWN*, N/D87).

Using radio operator license class as a "crude measure of duration of licensing," Milham found that members of the FCC's novice class did not show the increase in cancer mortality observed in the other, more experienced classes. Novices, who are limited as to transmitter power and restricted to certain transmission frequencies, may not have "been exposed long enough to fulfill a cancer latency period" or may have been less exposed to "whatever carcinogenic agents may be operating," Milham explained in a letter to the *American Journal of Epidemiology*. The novice class, in a sense, "provides an internal control group," he said.

The new analysis "adds a lot of credibility to the other findings and fits exactly with what you would expect in an occupational cohort in terms of latency parameters," Milham told *Microwave News*.

Milham proposed that it should now be possible to study the effect of license duration on mortality and to determine the interval between initial licensing and development of disease by tracking "individual license holders through successive [FCC] registration files."

Milham's letter was published in the November 1988 issue of the *American Journal of Epidemiology (128*, pp.1175-1176); the original study appeared in the journal's January 1988 issue *(127*, pp.50-54). Milham's first report of a link between radio operators and cancer based on an analysis of mortality records of members of the American Radio Relay League was published as "Silent Keys" in the league's monthly magazine *QST* (see *The Lancet*, April 6, 1985, and *MWN*, My85).

Also, in a letter to the editor which appeared in the following issue of the journal (December 1988), Dr. Thomas Kurt, a Dallas, TX, researcher, pointed out that the onset of AIDS, as well as the nationwide increase in non-Hodgkin's lymphoma over the past 40 years, may have contributed to Milham's original findings. Milham, using data from his new study on license class, discounted these assertions.

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Leukemia in Sweden

Male Swedish electrical line workers had nearly double the expected incidence of chronic lymphocytic leukemia (CLL), according to a study by a group of U.S. and Swedish researchers led by Dr. Martha Linet of the National Cancer Institute in Bethesda, MD. This finding was statistically significant.

The U.S.–Swedish team also reported that electrical line workers did not show a significantly increased incidence of other types of leukemia, including acute non-lymphocytic leukemia (ANLL), and that, "No excess [ANLL] was seen in other occupational groups potentially exposed to electromagnetic fields" (EMFs).

When asked about the significance of the line worker-CLL association, Linet told *Microwave News* that, "It's one finding, one study. It needs to be followed up with more research."

A previous Swedish epidemiological study had identified a non-significant increase in total leukemia—though not in any subtype—among power linemen (see *MWN*, M/J86). Linet and coworkers suggested that, since the risk of CLL is highest among older people, the previous study by Dr. S. Tornqvist and associates may have missed this finding because, unlike Linet, Tornqvist did not include males over 64 years old.

Using the Swedish Cancer-Environment Registry, which links national cancer data from 1961 through 1979 with employment information, the researchers observed a number of new leukemia-occupation associations, including chronic myelogenous leukemia among brewery workers and motor mechanics and CLL among cloth and pattern cutters. The registry does not contain data on employment duration or on specific exposures, such as radiation, benzene or other potential carcinogens.

Linet's study appeared in the *American Journal of Industrial Medicine, 14*, pp.319-330, 1988.

Parental Occupational Exposures

A case-control study of children with central nervous system (CNS) tumors showed no consistent association with parental occupational exposures to EMFs. Dr. Philip Nasca and coworkers at the New York State Department of Health pointed out that their study does not rule out a link between EMF exposures and tumors of the peripheral nerves.

The study did reveal an increased risk of cancer among the children of fathers with jobs associated with exposures to ion-

izing radiation. (This association was apparent when exposure was based on industrial codes, but not on occupational titles.)

The researchers investigated 338 children under the age of 15 diagnosed with CNS tumors between 1968 and 1977 in New York state. The study appeared in the December 1988 issue of the *American Journal of Epidemiology (128*, pp.1256-1265).

Emphasize Science, Not Statistics

The public is being unduly alarmed by epidemiological studies that are scientifically flawed, an epidemiologist at the Yale University School of Medicine charged in the December 2, 1988 issue of *Science*. Dr. Alvan Feinstein based his view on studies which implicated a "common entity of daily life"—not infectious diseases; some of these studies passed peer review and received wide publicity only to be discredited later.

Using as examples three recent studies linking reserpine (a medication for hypertension) with breast cancer, coffee with pancreatic cancer and alcohol with breast cancer, Feinstein argued that the epidemiologists overlooked fundamental scientific standards. Since their publication, the reserpine and coffee risk studies have both been refuted.

Feinstein recommended that, in the future, epidemiologists should place more emphasis on the scientific quality of the evidence, and less on the statistical methods of analysis and adjustment.

OTA on EMPRESS II: More EMI Testing Is Needed

The U.S. Navy's electromagnetic pulse (EMP) simulator, EMPRESS II, presents "no significant health effects" threat to humans and wildlife on land or to marine life when operating in the Atlantic Ocean, 15 miles off the coast of North Carolina, according to a new analysis by the Congressional Office of Technology Assessment (OTA). The report does recommend additional testing to gauge EMPRESS II's threat of electromagnetic interference (EMI) to avionics.

The OTA's Dr. Anthony Fainberg, the author of *The Potential Biological and Electronic Effects of EMPRESS II*, does recommend that it would be "imprudent" to have Navy personnel aboard the ships exposed to 50 kV/m electromagnetic fields (EMFs), given the uncertainties in knowledge and "particularly since simple shielding could reduce the field strengths to far lower values." He notes that the rate of cancer among Boeing workers exposed to EMP, though not "definitive," might be "a cause for concern and an indication for further study." Since the OTA report was issued, Dr. Sam Milham, Jr., has called for a national EMP health study (see *MWN*, N/D88).

Fainberg highlights research needs related to EMI. He points out that the Navy has neither examined the effect of EMPRESS II on flight electronics nor determined the EMF levels at the boundary of the 6,000-foot-high exclusion zone. "Both of these issues should be resolved by appropriate testing," he recommends, calling the present uncertain situation "somewhat disturbing." Marine traffic will be excluded from approaching within two miles of EMPRESS II.

Of special concern, according to Fainberg, is EMI to "fly-by-wire" aircraft—those, such as the Boeing 757 and 767 and the Airbus 320, which are controlled electronically instead of mechanically. He notes that the Boeing 767 is designed to withstand peak EMFs of only 100 or 1,000 V/m, depending on frequency. Fainberg advises that, "It would be vital to assure that no unhardened 'fly-by-wire' aircraft come within the 100 V/m range, which might be as far as 25 nautical miles away. Over the site, the 100 V/m altitude might be around 60,000 feet, beyond the limit of commercial aircraft."

Fainberg notes that the U.S. Army's Harry Diamond Labs is considering operating a similar EMP tester (VEMPS II) at its Woodbridge facility in Virginia, 15 miles from Washington's National Airport and only a little further from Andrews Air Force Base and Dulles International Airport. "Given the presence of [VEMPS II] near three large airports in the Washington, DC, metropolitan area, a solid understanding of EMP on commercial aircraft seems vital," he warns.

While "EMPRESS II levels appeared to cause no damage to tested marine electronics at levels equivalent to those at the edge of the two-mile exclusion zone," Fainberg adds that, "Momentary upsets of depth-finding equipment were noted," and that, "Within the zone, a LORAN-C receiver suffered upsets that could be difficult to detect." The LORAN-C was affected by levels above 4.3 kV/m. Fainberg advises that an examination of the susceptibility of "a wider variety of equipment than has already been tested" is needed.

The OTA report was requested by Congressman Walter B. Jones (D-NC), the chairman of the House Committee on Merchant Marine and Fisheries. Jones's district includes Curri-

U.S. Army To Prepare EMP EIS

On January 11, the U.S. Army announced that it will prepare an environmental impact statement (EIS) on its EMP simulators at its Woodbridge, VA, facility. The EIS will cover health and environmental effects, as well as EMI to medical, aviation and marine electronics. Public meetings were held on January 30 and 31.

The Army has targeted the completion of the EIS for September 1989, according to Dave Davison of the U.S. Army Laboratory Command's Public Affairs Office.

The EMP testers at Woodbridge have been shut down since April 1988, as part of a settlement of a lawsuit which sought EISs for most military EMP facilities (see *MWN*, M/J88). For more information, contact: Marian Singleton, Army Laboratory Command, Attn: AMSLC-PA, 2800 Powder Mill Rd., Adelphi, MD 20783.

tuck County, which borders on EMPRESS II's ocean site. Jones sought this independent OTA review to calm fears and concerns among his constituents.

Edmund Welch, chief counsel to the committee, told *Microwave News* that no follow-up was planned by the committee, but that Congressman Jones "will continue to monitor" EMPRESS II activities.

EMPRESS II, an acronym for the second Electromagnetic Pulse Radiation Environment Simulator for Ships, has been at the center of a controversy for many years (see *MWN*, O84, N84, J/F87 and M/J88). The Navy had originally planned to use the simulator in the Chesapeake Bay but finally selected the Atlantic Ocean site when faced with intense opposition from elected officials in Maryland and Virginia.

Among Fainberg's other findings are:

- "There appears to be a lack of hard data to justify the [U.S. Air Force's 100 kV/m personnel] standard."
- Residents of Corolla, NC, the closest land-based population, are exposed to 80 V/m from EMPRESS II, according to Navy measurements.
- "Tests on birds show that homing is still accomplished after exposure to EMP, although some disorientation may occur," and "It is unlikely that the effect of EMP on migration is greater than the effect of natural lightning."
- Exposure to test EMPs—not simply computer simulations or sub-scale modeling—is "necessary" to verify the hardness of ship electronics.

For more information, contact: Dr. Anthony Fainberg, International Security and Commerce Program, OTA, U.S. Congress, 600 Pennsylvania Ave., SE, Washington, DC 20510, (202) 228-6429.

Professor Saul Rosenthal 1918-1989

After a period of declining health, Dr. Saul Rosenthal suffered a cerebral hemorrhage and died on January 15.

An associate professor of electrical engineering at Polytechnic University in Brooklyn, NY, Rosenthal was a leading member of the bioelectromagnetics community. From 1968 to 1988, he was the chairman of what is now called the American National Standards Committee C95 on Non-Ionizing Radiation Hazards—and he played a key role in shepherding the 1982 ANSI standard through its lengthy approval process. Rosenthal was one of the original board members of the Bioelectromagnetics Society (BEMS) and was an active participant in the IEEE and URSI.

Much of Rosenthal's research was on the biological effects of microwaves and millimeter waves—specifically, on the potential damage of microwaves to the eye and on the attempted replication of Soviet cellular studies on low-level millimeter waves.

Rosenthal was an early and enthusiastic supporter of *Microwave News*. When the newsletter was still in the planning stages, he encouraged us to go forward and, during the crucial first years of publication, he was always ready and willing to help. Saul Rosenthal was most generous to us, and we will miss him.

Picking the Right RF Meter

Power densities measured with broadband radiofrequency (RF) meters can be incorrect by as much as a factor of 50, according to tests by Ed Mantiply of the U.S. Environmental Protection Agency's (EPA) Office of Radiation Programs.

Mantiply recommends the use of specific types of meters for different types of sources. For single FM stations, any meter designed for this frequency range (88-108 MHz) will yield "good results." In areas where there are multiple FM and/or TV stations, a meter with a thermocouple (e.g., a General Microwave Raham 3 or a Narda 8621/8631 probe) or a square-law diode-based instrument (e.g., a General Microwave Raham 4A or a Narda 8652/8662 probe) should be used. If an electric field is to be measured in the presence of significant AM broadcast fields, a meter which is immune to RF potential sensitivity (e.g., Instruments for Industry EFS-1) is desirable.

In a paper presented at the *10th Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, held in New Orleans, LA, last November, Mantiply outlined the types of problems which can lead to spurious readings: RF potential sensitivity, non-sinusoidal and out-of-band responses, zero instability and non-isotropy.

RF potential sensitivity can come into play at frequencies below 10 MHz when the meter responds to the RF potential difference between the probe and the meter instead of to the electric field in the vicinity of the probe. And non-sinusoidal fields can lead to measurements which are 1-2 dB too high.

If an RF meter is used in the presence of fields outside its specified frequency range, "unpredictable" responses may result. For instance, Mantiply indicates that some meters will be influenced by 60 Hz electric fields. Zero stability can also be tricky because the zero point may only drift when the field is applied—otherwise, it appears to be stable.

For more information, contact: Ed Mantiply, Office of Radiation Programs, EPA, PO Box 98517, Las Vegas, NV 89193, (702) 798-2476.

Canada Adopts New Computer EMI Standards

On February 1, new rules governing electromagnetic emissions from computers went into effect in Canada. The regulations parallel—and were in fact prompted by—those already adopted in the U.S. by the Federal Communications Commission (FCC).

"There are a few minor differences between the two sets

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The **New York Power Authority (NYPA)** went on an early December field trip to Sandspoint and East Williston, both in NY, to take magnetic field measurements next to an **underground 345 kV line**—similar to a proposed 25-mile power line to run under Long Island Sound. The fields measured directly above the buried line in Sandspoint were less than 1 mG; in contrast, measurements taken under a nearby overhead distribution line showed levels of 2.5 mG. Officials from East Williston, one of the towns opposing the new line, accompanied NYPA on what it described as a "demonstration." In May 1988, the state PSC approved the route, which, according to a NYPA spokesman, now only needs a permit from the U.S. Army Corps of Engineers before construction can begin. Meanwhile, a group of Westchester residents who are protesting the line are disappointed over NY Governor **Mario Cuomo**'s last-minute veto of a bill which would have required NY utilities to consider siting power lines along state highways rather than along local streets—including those in their own neighborhood (see *MWN*, M/J88). Undaunted, the group is now pressing state legislators to re-introduce the bill in the new session.

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Electrical World offered some advice in its November issue concerning "What Utilities Can Do About the EMF Threat." First, the magazine noted that, "Scant evidence exists to prove" claims that EMFs contribute to cancer and other health effects: "The outlook for utilities planning critical new transmission projects is not bright at this time for, as in acid rain and greenhouse issues, perception seems to be more powerful than reality. In other words, whether or not EMFs are harmful is irrelevant. What is relevant is the fear that they are harmful." Then it endorsed the approach taken by the New York Power Authority in the Marcy-South lawsuit—lining up experts who conclude that EMFs do not cause cancer and showing that land next to power lines has not been devalued.

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In January, the Sandpiper Shores Elementary School in suburban **Boca Raton, FL**, opened on schedule, despite a last-minute class action suit filed against the Palm Beach County school board (see *MWN*, S/O88). Three of the children's parents are seeking a permanent injunction against the opening of the school, which is located within 230 feet of five power lines. At a preliminary courtroom hearing on December 13, Dr. **Andrew Marino** testified that opening the school would "constitute a human research experiment on the children." A different view was offered by Dr. **Morton Miller**, testifying for the school board: There is no scientific evidence that EMFs cause any deleterious biological effects, he said, even though he did recommend further research. A trial date has been set for May 8. Phyllis Atler, president of Citizens Endorsing a Safer Environment (**CEASE**), a parents group which continues to oppose the school's opening, told *Microwave News* that most CEASE members are not sending their children to the school, and that others are sending their children for the remainder of the semester only and will make other arrangements for the next school year if the court does not take action. Some of the parents believe that the school board relied on misleading and biased information from scientists on utility payrolls in making its decision to open the school. At an October 26 informational hearing, experts told the school board that the magnetic field levels surrounding the school are within "safe" limits. But Atler claims that the experts—Drs. Philip Cole, Paul Leaverton, Samuel Milham, Jr., and Harrison Mehn—were supplied with an outdated maximum field measurement of 1.4 mG; the highest levels measured were closer to 2.8 mG (45 feet from the school). In addition, the lines are only being used at 48% capacity, she said.

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In the October/November issue of the ***EPRI Journal***, James Hall looks at ways to improve power lines to meet a number of objectives, including **reducing EMFs**. Using the ENVIRO software, developed at EPRI's High-Voltage Transmission Research Center in Lenox, MA, Hall compared the electric and magnetic fields from a standard double-circuit 230 kV line and from a compact six-phase 230 kV line. The electric fields were roughly the same in each case, but the magnetic fields associated with the six-phase line were approximately half of those from the double-circuit line.

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Central Maine Power Co.'s (CMP) plans to purchase 300 MW of electricity from **Hydro-Québec** for $4 billion over the next 29 years have been put on hold. On January 9, the Maine Public Utilities Commission (PUC) voted 2-1 to deny CMP permission to build a power line composed of two segments —42 miles at 345 kV AC and 92 miles at 450 kV DC—across western Maine. According to the PUC, the utility did not show that the proposed contract was the "least cost energy plan," and failed to adequately assess in-state production and conservation. The decision was not based on health or environmental concerns—the power line would have required cutting down 2,000 acres of trees and would have crossed the Appalachian Trail. Pamela Prodan, a member of **No Thank Q Hydro-Québec**, a citizens group opposing the project, told *Microwave News*, "In this particular case, the PUC wasn't ready to look at the economic impacts of health effects."

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On April 4, Dr. **Bill Feero** of Electric Research & Management will chair a panel on power line EMFs at the ***11th IEEE/PES Transmission & Distribution Conference and Exposition*** in New Orleans, LA. Among the panelists will be Robert Black and James Mitsche, both of EPRI, Dr. Lee Rosen of W/L Associates and James Vick of Gulf Power Co. The T&D expo is the largest meeting of its kind—the last one, held in 1986, attracted more than 10,000 participants.

Sheppard to Seattle City Light: Consider Epidemiological Data

"It is now reasonable to consider epidemiological evidence in making public policy" on power lines, Dr. Asher Sheppard advises in a report to Seattle City Light (SCL), a Washington state utility. Sheppard adds, however, that, "It would be wrong to treat the evidence as if a cause and effect relation had been proven" and that, "It will not be possible to confirm or rule out an association between 60 Hz fields and cancer for some time."

When asked by *Microwave News* whether he would recommend a magnetic field exposure limit based on the Wertheimer-Leeper and Savitz epidemiological studies, Sheppard replied that, "I can't recommend a number that would serve as a 'standard' for magnetic field exposures but what I do recommend is that on the basis of the epidemiological data, milliGauss (mG) fields may influence cancer incidence."

Sheppard did suggest that in planning new power lines, SCL should take a close look at the routing to see who is at risk and what the economic impact may be. Then the utility should let the ratepayers decide the preferred course of action. Sheppard, who is on the research staff at the Veterans Administration Hospital in Loma Linda, CA, prepared his report as a consultant to SCL.

Laurie Geissinger of SCL's Environmental Affairs Division told *Microwave News* that, "The Sheppard report will indeed influence the way SCL presents any new proposals for facility upgrades, including power lines." Like Sheppard, Geissinger shied away from a specific magnetic field standard: "The next logical step is not trying to impose specific standards when we don't know if we are purchasing any increased benefits with respect to public health. Instead, we are getting ready to make changes in design that may be warranted in the future." She added that the utility is now also investigating whether there are areas of high exposure.

In a critique of Sheppard's report, Dr. Robert Becker, a consultant based in Lowville, NY, argues that the evidence of harmful effects is "sufficiently compelling to require that any new transmission line be constructed in such a fashion as not to expose any residence or school building...to any 60 Hz magnetic field in excess of 3 [mG]." However, he does add that, "I do not advocate that this standard be immediately placed on all existing facilities" because "such an action would result in the failure of our electric power system with unacceptable risks to the general population."

In his comments, Becker dismisses as "patent nonsense" the NY Public Service Commission's decision—following the release of the NY Power Lines Project final report—to set a field strength limit of 100 mG at the edge of 345 kV rights-of-way (see *MWN*, M/A88 and N/D88). Becker prepared his comments at the request of Citizens Against Overhead Power Lines (CAOPL), a Seattle citizens group organized to fight a

SCL Policy Statement on EMFs and Human Health

Seattle City Light (SCL) is committed to providing safe, reliable and environmentally sound electric service for its customers and a safe work environment for its employees. The Utility adheres to the Washington State Standards for Electrical Construction Code and Electrical Workers Safety Rules (WAC Chapter 296-44 and 45) and complies with other applicable regulations governing installation of electrical facilities. Additionally, the Utility is committed to public involvement in determining where electrical facilities should be located.

The utility is aware of the ongoing research effort to identify the biological effects of power frequency (50-60 Hertz) electric and magnetic fields (EMFs) and to determine if such effects have any implications for human health. Research on EMFs covers a wide range of subjects, such as studies concerning reproduction, cancer and behavior. Studies of humans include both workers and people without work-related exposure.

Exposure of people to electric and magnetic fields from electrical transmission, distribution, and appliances may or may not be found to affect health. At this time, whether such fields can produce or promote change that impairs or otherwise compromises health is a matter of great scientific uncertainty. However, the fact that some studies even suggest a link between electric and magnetic fields and health requires assertive steps by the utility industry and government agencies to answer questions pertaining to possible health effects. SCL acknowledges the scientific uncertainty and public concern about possible health effects. Any potential risk to health is viewed as a serious concern by the utility. SCL's policy on this topic will be used to guide decision-making of the utility that involves consideration of electric and magnetic field effects.

Statement of Policy

It is the policy of SCL to share its knowledge of the available information on the biological and possible health effects of electric and magnetic fields in open internal and public communications about research and regulatory developments, and to ready the utility for operational changes that could be warranted in the future. This will be accomplished by establishing an interdisciplinary work group with responsibility for:

- Monitoring research and regulatory developments
- Registering concerns about possible health effects and responding in a coordinated manner to requests for information on electric and magnetic fields from the public and SCL employees
- Initiating the conveyance of information to enhance understanding of electric and magnetic field effects as dictated by milestones in the research and/or heightened sensitivity of the public and employees
- Identifying and proposing means by which SCL may work with other electric utilities to advance and support research in this field
- Making recommendations concerning changes to design standards and/or system operating practices that may be warranted.

230 kV line first proposed by SCL in 1984.

In his report, Sheppard proposes that SCL expand its 1986 final Environmental Impact Statement (EIS) on the 230 kV Highline power line project to include magnetic—as well as electric—field concerns. SCL's Geissinger said that the Highline project has been "shelved" for at least three to five years.

Among Sheppard's other recommendations are that SCL prepare a supplemental EIS with an emphasis on risk assessment, taking into account recent epidemiological studies; set up an EMF task force; evaluate potential risks associated with power lines and substations; assess existing facilities to estimate potential health hazards; and consider delaying new power line projects until more information has come in.

CAOPL calls for the creation of an oversight group made up of experts not affiliated with utilities, to be independently funded and administered by a public health agency. In the meantime, CAOPL wants SCL to "stop all construction of proposed...lines and substations" and to take "accurate 24-hour measurements of existing 'hot spots' of chronic exposure levels."

SCL recently adopted a policy statement on human health and electric and magnetic fields (see p.7) and will soon finalize a work plan for the next few years.

Update on the Scientific Literature Concerning Health Effects of 60-Hz Electric and Magnetic Fields of Power Transmission and Distribution Facilities, which was released in September 1988, was prepared at the order of Seattle City Council Resolution 27741. The report is available from: Laurie Geissinger, Seattle City Light, 1015 Third Ave., Seattle, WA 98104, (206) 684-3462.

NAS-NRC ELF Workshop

The National Academy of Sciences-National Research Council (NAS-NRC) will host a one-day workshop on extremely low frequency (ELF) fields in Washington, DC, on March 14. The purpose of the workshop is to see how this field of study has developed over the last few years and to determine whether the NAS-NRC should devote more attention to it, according to Dr. Ray Cooper of the NAS-NRC's Board on Radiation Effects Research.

An ad hoc panel, chaired by Dr. Richard Setlow of Brookhaven National Lab, has been assembled to review the ELF data. The panel will hear from six experts: Drs. Martin Blank of Columbia University; Craig Byus of the University of California, Riverside; David Carpenter of the NY State Department of Health; Russell Reiter of the University of Texas Health Science Center; David Savitz of the University of North Carolina, Chapel Hill; and Tom Tenforde of Battelle.

The NAS-NRC held similar workshops in 1983 and 1985 (see *MWN*, D83 and N/D85). In a report, *Non-Thermal Effects of Non-Ionizing Radiation*, issued following the 1985 meeting, the NAS-NRC panel concluded that, "Abundant fragmentary evidence has been presented in support of possible biological effects from non-ionizing radiation, at both transmission line and microwave frequencies. These effects often appear to be unaccompanied by macroscopic thermal changes" (see *MWN*, M/J86).

"Things have changed quite a lot since the earlier workshop," Cooper told *Microwave News*, "but I am not sure that there is enough information to say anything definitive [about ELF mechanisms]." Academy members and federal officials have been invited to the workshop. Those wishing to attend should contact Cooper directly at the NAS-NRC, 2101 Constitution Ave., NW, Washington, DC 20418, (202) 334-2743.

FROM THE FIELD

On March 27-31, the Maryland Public Service Commission will hold hearings on the health effects associated with exposure to extremely low frequency (ELF) electromagnetic fields (EMFs). The hearings are the latest stage in the Potomac Electric Power Company's (PEPCO) 12-year struggle to build the 10-mile 500 kV Brighton-High Ridge power line—the only unbuilt piece of a 243-mile loop around Washington, DC (see MWN, *M/A88 and S/O88). The following is excerpted from expert testimony filed by some of the parties and intervenors in the case.*

For PEPCO

Dr. Edwin Carstensen, Professor of Electrical Engineering and Biophysics, University of Rochester, NY.

Q. What is the scientific consensus on the effects of transmission line EMFs on health and safety?

A. Over the past decade, there have been in excess of 15 reviews of this subject by consensus groups throughout the world. These scientific and governmental bodies have identified three potentially adverse effects from exposure to transmission line fields—shock from contact with conducting objects, the related effects on productivity in honeybees, and inhibition in a limited subset of implanted cardiac pacemakers. The National Electrical Safety Code contains a 5 mA standard to address the potential for adverse shock effects. That standard appears to have been 100% effective in eliminating shock-related accidents. As I noted before, the effect on honeybees can be eliminated by shielding the hives. With respect to pacemaker inhibition, the consensus is that this is a manufacturing defect and that the solution to the problem lies with the manufacturer.

Dr. Mark Israel, Chief of the Molecular Genetics Section of the Pediatric Branch, Division of Cancer Treatment, National Cancer Institute (NCI), Bethesda, MD.

Q. Based upon your experience and research as a pediatric oncologist and cancer researcher, is there any scientific evidence that would lead you to believe that exposure to power frequency EMFs causes, promotes, or otherwise leads to the development of cancer?

A. No.

Q. In your opinion, is there any scientific basis to believe that exposure to the EMFs from the Brighton-High Ridge 500 kV transmission line would cause, promote, or otherwise lead to the develop-

ment of cancer?
A. No.
Q. Dr. Israel, let us assume that the magnetic field levels at the edge of the right-of-way [ROW] for the Brighton-High Ridge line would be as high as 200 mG. Based upon that assumption, is there any scientific evidence that would lead you to believe that exposure to magnetic fields from the Brighton-High Ridge line would cause, promote, or otherwise lead to the development of cancer?
A. No.

Dr. Margaret Tucker, Chief of the Family Studies Section of the Environmental Epidemiology Branch, NCI, Bethesda, MD.
Q. What do you conclude based upon your review of the occupational and residential epidemiological studies of EMFs?
A. I find no consistent pattern of risk of cancer in children or adults, no indication of a dose/response relationship, and in certain studies, an inadequate assessment of the impact of probable confounders.
Q. In your opinion, do the occupational and residential studies fail to show a consistent pattern of risk because the research has not advanced far enough?
A. No. The epidemiology research is fairly far advanced. For example, at the same stage in the cigarette/cancer research, one could make a conclusion about the relationship between cigarettes and cancer, because there was a consistent pattern of risk within and across the studies.
Q. What is your opinion on the risk of cancer from exposure to EMFs?
A. The research in epidemiology in this area has yielded no persuasive scientific evidence of an increased risk of cancer in children or adults from exposure to power frequency EMFs.
Q. Dr. Tucker, let us assume that the magnetic field levels at the edge of the ROW for the Brighton-High Ridge line would be as high as 200 mG. Based upon that assumption, is there any scientific evidence that would lead you to believe that exposure to magnetic fields from the Brighton-High Ridge line would increase the risk of cancer in children or adults?
A. No.

For Maryland People's Counsel

Dr. Charles Polk, Professor of Electrical Engineering, University of Rhode Island, Kingston, RI.
Q. Were you aware of the work of Wertheimer and Leeper before the results of the Savitz study were published and what was your opinion concerning their findings?
A. Yes, they are discussed in...the *Handbook of Biological Effects of Electromagnetic Fields*, which I edited. In 1984 or 1985 I was very skeptical concerning the validity of their findings, primarily because I did not believe at that time that the "wire configuration code," which they used, was really a valid measure of long-term magnetic field exposure. I also discounted the results, because the classification of residences into wire codes was not done "blind"; that is, the classifier was aware of whether or not the particular residence corresponded to a cancer case.
Q. Have you changed your opinion concerning the Wertheimer-Leeper studies?
A. Yes, because the much more elaborate study by Savitz and coworkers gave results very similar to the earlier findings. Also, measurements over 24-hour periods by Kaune and coworkers (*Bioelectromagnetics, 8*, p.315, 1987) in 43 homes indicated that the Wertheimer-Leeper wire codes predicted reasonably, although imperfectly, average magnetic field levels. Finally, I concur now with the suggestion by Savitz that the Wertheimer-Leeper wire codes may be a better indication of *long-term, historical* magnetic field exposure of *former* residents of a home (who died of cancer) than current short-time (hour or less) field measurements which are affected by such variables as recent home wiring changes or purchase of new appliances.
Q. What do you believe are the implications of the New York power lines study and of the laboratory investigations which you described for the construction of the proposed 500 kV transmission line in Maryland?
A. While it is probably impossible to wait several years for the availability of further research results, I believe that caution is in order. Since the Savitz and Wertheimer-Leeper and Tomenius studies suggest a possible association of cancer with long-term exposure to magnetic fields above 2.5 or 3.0 mG, it is clearly desirable to reduce the magnetic fields from the line as much as possible in areas where dwellings are located.

For Howard County, Maryland

Dr. Jerry Phillips, Cancer Therapy and Research Foundation, San Antonio, TX.
Q. Do the results of your studies provide any explanation of a manner in which EMF exposure might be associated with an increased incidence of cancer or other illness or disease?
A. Yes. Cancer is a disease that appears to develop in stages. The first stage, known as initiation, is irreversible and involves at least one heritable change in the structure of the cell's genetic information, its DNA. The second stage, known as promotion, involves a series of reversible changes during which this initiated cell that was produced undergoes continued growth and further change that ultimately results in the production of a cell that is recognizable as a cancer cell. During the final stage, which is known as progression and is irreversible, certain more cancerous variants become dominant and have selective growth advances and survival advances over other cells in the tumor. Therefore during this phase of progression, one sees the emergence of increasingly diverse cancer cells with enhanced survival and growth characteristics. In lay terms, this stage of progression has been defined as that stage during which tumors go from bad to worse. Within this framework then, one can see a relationship between the work performed in my laboratory and those events that are characteristic of the stage of progression in tumor development. As stated above, human cancer cells exposed to EMFs demonstrated an increased capacity to grow, as well as an increased resistance to destruction by natural killer cells, which are cells that are part of the body's normal defense system. These cells, then, after exposure to EMFs, have demonstrated enhanced properties of growth and survival. It would appear that EMF exposure has taken a bad situation and made it worse....
Q. Dr. Phillips, do you have an opinion, based upon your individual research and your review of studies conducted by other scientists and physicians, whether there are biological or adverse health-related effects from exposure to EMFs?
A. Yes, I do.
Q. What is your opinion?
A. It is incontrovertible that exposure of biological systems to EMFs produces changes in those systems. Furthermore, it is my opinion that it is probable that the observed changes in biological structure and function are related to adverse effects on human health and development. I have stated in the past that I believe there is indeed a problem associated with human exposure to EMFs and that the only way to properly define the nature and magnitude of that problem is through continued research. Until we can define whether or not there is a problem, in what areas a problem exists and how big that problem might be, I believe it is imperative to minimize exposure of the general public as much as possible.

For Maryland Department of Natural Resources

Dr. William Bailey, Vice President, Environmental Research Information, Inc., New York, NY.

Q. Is there any evidence that there may be a health hazard associated with the EMFs generated by transmission lines?

A. Several epidemiological studies have reported that some types of electric utility wiring configurations (primarily relating to the number and thickness of distribution lines and their distance from residences) are found more frequently outside the residences of cancer cases than outside the residences of individuals without cancer....This has led to the hypothesis that this association reflects a low but increased risk of cancer from exposure to power line magnetic fields. If the hypothesis were true, then possibly all sources of magnetic fields, including household wiring and electrical appliances, would be associated with increased risk, as well as transmission lines.

Q. Do these studies prove that power lines cause cancer?

A. No. These studies are open to other interpretations and none has proved that the reported associations are causal. In addition, a larger number of other similar epidemiological studies have not observed any such association. An important consideration that also argues against a causal relationship is the fact that such associations (between wiring configurations and cancer) are not confirmed in those studies in which exposure to magnetic fields in the residence was determined by actual measurement.

Q. What about epidemiological studies of workers in "electrical" occupations?

A. There have been about 30 epidemiological studies which have looked for associations between job titles in "electrical" occupations and cause of death. These descriptive studies do not include measurement-based estimates of exposure to EMFs or to known or suspected chemical carcinogens that are widely prevalent in "electrical" occupations. Therefore, it is difficult to determine what field exposure might have contributed to mortality, independent of other factors. Without such information, these studies are of little help in documenting health risks. The studies also are not consistent in their findings....

Q. Have laboratory studies of animals or cells isolated from animals and humans, exposed to EMFs produced findings that would indicate that these fields cause cancer?

A. The evidence clearly weighs against this possibility....Neither has the behavior of normal or cancerous cells been shown to be affected by field exposures in ways that would characterize fields as having tumor-promoting properties.

Q. Is the evidence which suggests there might possibly be a health hazard from EMFs adequate to cause changes in public policies regarding the routing of transmission lines?

A. Not on the basis of the evidence that is now available....The results of currently available epidemiological and laboratory research on EMFs together do not support the conclusion that the operation of a 500 kV transmission line would produce cancer or other health hazards in adjacent populations.

Thomas Magette, Manager, Nuclear Programs for the Maryland Power Plant and Environmental Review (MPPER) Division; Department of Natural Resources.

Q. What are MPPER Division's conclusions?

A. Based upon our evaluation of the existing research, we do not believe that the operation of the 500 kV Brighton-High Ridge transmission line will result in any adverse health effects.

Q. Would you then say that there is no risk of a health effect from the operation of this line?

A. If there is any risk of a health effect, it is extremely low, and is easily outweighed by the benefits of the electrical transmission system, including the Brighton-High Ridge line.

J. Patrick Reilly, Johns Hopkins University Applied Physics Laboratory, Laurel, MD.

Q. What are the calculated maximum field levels within the ROW for the existing 230 kV lines?

A. The maximum field level for the existing four-circuit 230 kV lines is calculated as 95 mG under conditions described by PEPCO as "normal loading." Under "heavy loading" conditions, the calculated maximum level is 125 mG....

Q. What are the calculated maximum field levels within the ROW with the addition of the 500 kV line?

A. The calculated fields depend on which configuration is being considered. For configuration A, the maximum field level within the ROW is 77.3 mG under conditions described by PEPCO as "normal loading" and 101.0 [mG] under conditions described as "heavy loading." For configuration B, the maximum field level is 83.8 mG for "normal loading" and 118.4 mG for "heavy loading."

Q. Could you please explain how these fields could be lower following the addition of the 500 kV circuit?

A. The addition of an additional transmission line alongside existing lines can cause the total field to either increase or decrease at specific locations. The total field level is affected by several factors, among them the specific line designs, the current loads, and the interaction of the fields from each transmission line....

Q. What exactly do you mean by interaction of the fields?

A. Each wire in the transmission line circuit will produce its own magnetic field. The magnetic field at a distant point will be due to the combined effects of all the wires, but these effects are not necessarily additive in a simple sense because of the differing electrical phases. As a general rule, the fields from separate sources can combine in either a mutually reinforcing or canceling way, depending on the phases of the separate sources. The magnetic field components from the individual wires of a single transmission lines circuit will partially cancel one another at most locations distant from the lines. The efficiency of this mutual cancellation will depend on the geometric arrangement of the wires. As a rule of thumb, the cancellation becomes more efficient as the wires comprising a simple transmission line circuit are moved closer together, and also as the measurement point is moved more distant from the lines. If there is more than one transmission circuit in a ROW, the combination may be one of addition or cancellation depending on the relative phases of the wires in the different circuits and the location of the measurement point.

Q. What are the calculated field levels distant from the ROW?

A. ...the calculated fields are below a level of 0.5 mG somewhere between 400 and 1,000 feet from the centerline of the ROW. The precise distance depends on which configuration is being considered, the current load that is assumed, and the degree of electrical imbalance.

Q. What is the significance of a level of 0.5 mG?

A. 0.5 mG is a typical level found in many residences that are not located near high voltage transmission lines. Actual ambient residential levels depend upon a host of factors and could be higher or lower than that value.

Q. Is it possible that the magnetic fields might actually be greater than the ones you have calculated?

A. Yes, it is.

Q. What factors could cause the magnetic fields to be greater than the calculated levels?

A. Two major factors could result in magnetic field levels that are substantially greater than the calculated levels. One is higher current levels, the other is electrical imbalance.

UPDATES

BIOLOGICAL EFFECTS

PMF-Rat Study Shows Some Effects...PMFs had some adverse effects on pregnant rats and their offspring, but the Canadian researchers who ran the study generally discounted the significance of the effects. Dr. Maria Stuchly of Health and Welfare Canada in Ottawa, Ontario, first presented the results at the power line contractors' review in Kansas City, MO, in November 1987 (see *MWN*, N/D87). Female rats were exposed to PMFs at intensities of 5.7, 23 or 66 μT seven hours per day starting two weeks prior to impregnation and lasting throughout pregnancy. The fetuses exposed to 66 μT PMFs had a highly significant ($P<0.001$) increase in minor skeletal anomalies. One type of skeletal variation was also elevated in the 23 μT group. Stuchly and coworkers discounted these findings as "common 'noise' that appears in every teratological evaluation." The team also found statistically significant decreases in red and white blood cell counts among the rats exposed to 66 μT, as well as a small but significant change in one blood chemistry index among those exposed to 23 μT. Stuchly called this latter finding "incidental," but noted that the changes observed at 66 μT "could represent a toxic response to the magnetic field." These hematological findings were not reported in 1987. The results appear in *Teratology, 38*, pp.461 -466, 1988.

COMPATIBILITY & INTERFERENCE

"ENR" Changes Hands... The *Electromagnetic News Report (ENR)* has a new owner. The bimonthly newsletter, started 17 years ago by Robert Goldblum of R&B Enterprises, has been sold to Michael Howard, the president of Liberty Labs, Inc., which until now has been best known for its engineers' log books. In a telephone interview from his office in Cedar Rapids, IA, Howard told *Microwave News* that he plans to continue the current format, but will add new features and columns. For instance, in the first issue edited by Howard (January 1989), William Kimmel of Kimmel Gerke Associates Ltd., an EMI consulting firm based in St. Paul, MN, inaugurates an "EMC Notebook." Howard will also send his subscribers special bulletins—*ENR Express*—to highlight news that cannot wait until the newsletter's next issue. "We intend to provide up-to-date information to the EMC community," he said. When asked to compare *ENR* to both Don White's bimonthly *EMC Technology* and Dash, Straus & Goodhue's quarterly *Compliance Engineering*, Howard said that while *EMC Technology* is directed to the design engineer and *Compliance Engineering* emphasizes regulations and standards, "*ENR* will provide general news to the EMC community." *ENR* has a circulation of approximately 500, with a readership of 2,100, according to Howard. Subscriptions are $53.00/year in the U.S. and Canada and $68.00/year elsewhere. For more information, contact: Michael Howard, Liberty Labs, Inc., 4920 Johnson Ave., NW, Cedar Rapids, IA 52405, (319) 390-3646 or (800) 728-7081.

Louis Slesin, the editor of *Microwave News*, takes a look at the implications of the demise of EPA's non-ionizing radiation program and its decision not to issue federal exposure rules in "The Danger of Ignoring Non-Ionizing Radiation," which appears in the January 1989 issue of *Technology Review*, an MIT publication. Subscribers can get a complimentary copy by sending a self-addressed stamped envelope to: *Microwave News*, PO Box 1799, Grand Central Station, New York, NY 10163.

TEMPEST Industry Hurting... In our last issue, we noted that Frost & Sullivan, Inc. (F&S), was predicting a slower rate of growth for the TEMPEST products market. More recently, the January 23 *Washington Post* reported that the industry is struggling through hard times—and may therefore be in worse shape than was suggested by F&S. The *Post* quoted representatives from Washington, DC, area TEMPEST firms: "The industry in general is having a bad year," said John Innocenti of Atlantic Research Corp., who predicted "some tough times ahead" for the smaller companies. David Lucien, president of Tempest Technologies, Inc., said that "TEMPEST is leveling off" and that future growth will be more like 9 percent a year compared to the 30-40 percent levels of the past. The turnabout was blamed on a combination of a slowdown in the computer industry and a government spending freeze on data processing equipment.

EMP

FCC Petitioned Once More... Two Washington, DC, area residents are again trying to convince the FCC to open a notice of inquiry (NOI) on how best to protect civilian communications against an EMP. On November 28, Nickolaus Leggett and Donald Schellhardt filed a new petition asking the commission to reconsider its position that the NOI is unnecessary because other efforts are in progress—the basis for the FCC's refusal to act favorably on similar petitions in 1986 and in 1987 (see *MWN*, S/O86, J/F87 and M/J87). Leggett, a "technology analyst," and Schellhardt, an attorney, argue that, contrary to the commission's expectations, EMP protection standards are not expected from the National Security Telecommunications Advisory Committee (NSTAC) or from the American National Standards Institute (ANSI) in the foreseeable future. They cite a letter from the president of ANSI, stating that EMP standards are "not a priority" and that, "We have no idea when to expect their development."

GOVERNMENT

EPA Meets EEPA... The Board of Directors of the Electromagnetic Energy Policy Alliance (EEPA) met with Richard Guimond and Dave Janes, both of EPA's Office of Radiation Programs (ORP), in early December to try to convince them to change their minds and issue federal RF/MW radiation limits. The EPA staffers held their ground. Guimond, the head of

the ORP, explained, as he has in the past (see *MWN*, S/O88 and N/D88), that non-ionizing radiation is not a high priority at EPA or in Congress and that the agency had decided to tackle more important issues, according to Richard Ekfelt, EEPA's executive director. Ekfelt said that, as far as EEPA is concerned, the costs of *not* implementing the guidance are greater than the costs of doing so. In a telephone interview with *Microwave News*, Guimond explained that issuing the RF/MW guidance would not be enough in itself and that the agency would also have to implement it. He said that the agency would have to spend a million dollars and assign five members of the ORP staff during the current fiscal year to complete the rules and then would have to earmark the same resources for each of the next few years to educate industry and the public. When asked at the end of January if his prognosis for the guidance had changed, Guimond replied, "I don't see it in the cards at this time." EEPA has not given up the fight and is waiting for the new EPA Administrator, William Reilly, to take office to see if he is more responsive to its interests. Whatever Reilly's outlook may be, Guimond said that he expects to be staying on as the head of the ORP. Meanwhile, Ekfelt said that EEPA will continue to look for a receptive ear in Congress.

FCC and FM Boosters... The FCC has added FM booster stations to its list of facilities that require environmental analyses of RF/MW radiation levels before permits can be issued or renewed. The final action comes a year after the commission first proposed applying its rules governing the preparation of environmental impact statements to FM boosters, which are used to reach listeners who otherwise could not receive FM signals due to terrain obstructions (see *MWN*, J/F88). The FCC had originally exempted FM boosters because of their low-power transmission (see *MWN*, A85 and M/A87). The FCC changed its mind after the boosters were allowed to operate at powers of up to 20 kW. For more information, contact: Dr. Robert Cleveland, Office of Engineering and Technology, FCC, 1919 M St., NW, Washington, DC 20554, (202) 653-8169.

MEDICAL APPLICATIONS

FDA Faults Magnetrode... The FDA withdrew its approval of the Magnetrode hyperthermia unit last fall, according to a front-page story in the November 25 *Los Angeles Times*. The agency ordered that patients should no longer be treated with the unit, which was developed by Dr. Kristian Storm, formerly at UCLA and now at the University of Wisconsin, and which is manufactured by Henry Medical Electronics, Inc., in Los Angeles. The unit heats the body using 13.56 MHz radiation (see *MWN*, My81). The *Times* cited an October 6 letter from the FDA's Office of Device Evaluation which claims that researchers using the Magnetrode unit at nine medical centers have failed to prove its efficacy and safety. The *Times* also reported that the FDA was worried about the Magnetrode's potential for significant leakage, thereby exposing medical personnel to undesirable levels of radiation. Until his resignation in December 1987, Storm was the chairman of the ANSI subcommittee charged with revising the 1982 ANSI RF/MW safety standard (see *MWN*, M/A88).

MEETINGS

Electrical Potpourri...EPRI is sponsoring seminars on various aspects of power line design and analysis in Palo Alto, CA, during the first five days of May. One day each will be devoted to radio noise, lightning and EMF calculations; two days are reserved for power line EMC with railroads and pipelines. You can register for each topic separately or for all four together. For more information, including costs, contact: Valerie Kakaio, EPRI, PO Box 10412, Palo Alto, CA 94303, (415) 855-2798.

MW Susceptors and Migration... There will be a special session on microwave susceptors at *MW Foods '89*, to be held at the Drake Hotel in Chicago, IL, on March 15. Among the topics to be covered are susceptor safety, package migration, food product/package interaction, consumer safety, fires and hot spots. Jerome Heckman of Keller & Heckman, a Washington, DC, law firm, will chair the panel discussion; joining him will be Robert Schiffmann, a consultant based in New York City, and Dr. Lester Borodinsky of the FDA, among others. For more information, contact: The Packaging Group, PO Box 345, Milltown, NJ 08850, (201) 636-0885.

Bioelectricity Meeting Canceled... The *2nd Meeting of the International Society for Bioelectricity*, scheduled for March 10-12 in Denton, TX, has been canceled. According to Dr. Andrew Marino, the president of the society, the move was prompted by a lack of "quality abstracts."

MILITARY SYSTEMS

Nunn Seeks PAVE PAWS Evaluation... On January 4, Senator Sam Nunn (D-GA), chairman of the Senate Armed Services Committee, asked the USAF for an "official evaluation of the potential hazards of the PAVE PAWS radar emissions to aircraft flight safety and the long-term adequacy of the current operational procedures" at Robins AFB, GA. Nunn also requested a report on how the phased array radar can perform its space tracking mission with minimal risk to aircraft operations. "We may need to have an independent assessment," Nunn warned. In a January 27 letter to Nunn, USAF Brigadier General Burton Moore said that the USAF has "convened a General Officer Group to review the potential safety problems and make recommendations by June 1989." Over the past year, the Robins PAVE PAWS radar has been at the center of an EMI controversy over whether electro-explosive devices (EEDs) aboard aircraft flying through the radar's main beam are in danger of detonating (see *MWN*, J/A88). The USAF considered relocating the radar at a cost of $37.7 million because of this risk—but later rejected the proposal. In the meantime, a number of safety precautions for air traffic

have been instituted at the base and plans to upgrade the radar's power have been scrapped (see *MWN*, N/D88). These precautions include shutting down a portion of the radar whenever fighter planes carrying EEDs land at the base runway, according to the January 7 *Macon Telegraph and News*. Also on January 27, the director of the USAF Space Command office of public affairs wrote to the editor of the *Macon Telegraph and News* explaining that the original EED EMI hazard assessment was based on the average power of the radar but that a later review had indicated that "peak power was, in fact, a more accurate parameter to use."

...USAF Pays for Change of Channel... Georgia public TV station WDCO, whose signal interferes with the PAVE PAWS radar at Robins, is being reimbursed by the USAF for switching its broadcast frequency, according to the December 10 *Macon Telegraph and News*. Since 1986, when the phased array radar became operational, the USAF has regularly detected minor, low-level EMI caused by WDCO's transmitter located about 20 miles away. After WDCO asked the FCC for permission to upgrade its power output from 300,000 to 5 million watts, the USAF became concerned that the EMI would now compromise the PAVE PAWS mission to monitor sea-launched nuclear missiles and orbiting satellites and offered to pay for the change in frequency.

OCCUPATIONAL HEALTH

Workers To Get NIER Policy... Bath Iron Works (BIW) and the Occupational Health and Safety Administration (OSHA) have reached a settlement regarding BIW's numerous violations—including lax radar testing—at its Portland, ME, shipyard. In 1986, BIW workers claimed that they had been exposed to a U.S. Navy ship's radar and were experiencing health problems ranging from severe headaches and facial burns to raised blood pressure and fever (see *MWN*, J/A86). As part of its agreement with OSHA, BIW will completely restructure and implement a non-ionizing radiation policy and will introduce a "state-of-the-art" safety and health program at all of its plants by April 1, 1989. The company will also pay $650,000 in fines—much less than the record $4.2 million penalty originally proposed in 1987 (see *MWN*, N/D87). One unique part of the settlement calls for BIW to provide "substantial and meaningful financial" support for an "Occupational Health and Training Resource Center," to be located in Auburn, ME, for the benefit of all workers in the state.

STANDARDS

Canada: Power Line EMI... An amendment has been proposed to the Canadian Standards Association's RFI Regulations (standard C108.3.1) to expand protection from high-voltage power lines. The proposal provides for the transfer of responsibility for the investigation and resolution of complaints of power line-induced EMI from the Department of Communications to utilities. It also stipulates minimum performance standards for newly-constructed and modified power lines and for methods of measurement. The amendment was spurred by increasing numbers of power line EMI complaints; rising from 10,949 in 1980 to 16,560 in 1984. The amendment appears in the August 20 issue of *The Canada Gazette, Part 1*, pp.3361-3374. A copy is available from: JoAnne Overman, Office of Standards Code & Information, Admin. Bldg., Rm. A629, NIST, Gaithersburg, MD 20899, (301) 975-4037. Ask for TBT/Notif. 88.188.

New and Reaffirmed ANSI Standards...ANSI has published two new standards, *Recommended Practice for the Measurement of RF Emission from ISM Equipment Installed on User's Premises*, ANSI/IEEE 139-1988 ($45.00) and *EMC Limits—Recommended Practice*, ANSI C63.12-1987 ($49.50). ANSI has also reaffirmed *RF Radiation Hazard Warning Symbol*, ANSI C95.2-1982 (R1988) ($15.00) (see *MWN*, O81). Copies of all three standards are available (prepaid) from: Sales Department, ANSI, 1430 Broadway, New York, NY 10018. Shipping and handling are extra.

VDTs

Newsroom Miscarriage Cluster... Since September 1987, there have been 14 miscarriages among women working at the *USA Today* headquarters in Arlington, VA. The first report of the cluster appeared on the front page of the December 9 *Washington Post*, prompting other newspapers to pick up the story. Although the cause of the cluster has not been identified, employees speculated that VDT use or poor indoor air quality may have played a role. All of the women who miscarried used VDTs and worked in newsrooms that have been under heavy construction for nearly a year, according to the *Post*. About 100 women work in the division. In a December 13 follow-up item, the *Post* reported that air sampling tests failed to reveal any toxic contaminants in the building. NIEHS epidemiologist Dr. Allen Wilcox recommended further investigation of the cluster and told the *Post* that "...it sounds like an unusual number." (See also *MWN*, N/D88).

ETC...

BEMSNET Off the Air... Just before the new year, ONR's electronic mail network for the bioelectromagnetics community suddenly went off the air, leaving messages in limbo and severely curtailing communications among researchers. The system's carrier, DIALCOM, pulled the plug because of "contract complications" with ONR and GSA, according to ONR's Dr. Michael Marron. Apparently, DIALCOM had not been paid for months. As we go to press, negotiations are underway to find a new carrier.

What Is This Product?...A recent Macy's catalogue offers a product, "Finally Free," which removes "hair permanently without shaving, wax or cream. Low frequency radio waves travel to the hair root." Next to the listing is a picture of a woman using it to remove eyebrow hair. The price is $100.

Two members of NJDOH's own scientific advisory panel, set up to monitor the study, expressed surprise and dissatisfaction at the decision to abandon years of work. "It is my belief that the failure to complete the study is a breach of faith with the community, with those who agreed to serve as cases and controls, and with the scientific panel members," Dr. William Morton, an epidemiologist at the Oregon Health Sciences University in Portland, told the NJDOH in an October 26, 1988 letter. Morton added that the "decision to terminate the study before completion of data collection or analysis may have been political and/or economic, but it was not scientific and did not have the approval of the panel."

Similarly, Dr. Maureen Hatch, an epidemiologist at Columbia University in New York City, told the NJDOH that she was more than disappointed by the decision to abandon the study and, in an October 27 letter to the NJDOH, she threatened to resign from the panel.

In a telephone interview, Dr. Leah Ziskin, assistant commissioner of NJDOH's Division of Community Health Services, who is in charge of the study, said, "I respect [the panel members'] opinions, but from a public policy point of view, I feel that the department was justified in its decision."

Other panel members, including Chairman Dr. Nicholas Wright of the Robert Wood Johnson Medical School in Piscataway, NJ, and Ron Petersen, manager of non-ionizing radiation protection at AT&T Bell Labs in Murray Hill, NJ, supported NJDOH's decision.

Dr. Daniel Whartenberg of the Department of Environmental and Community Medicine at the Robert Wood Johnson Medical School, who reviewed the NJDOH report, told *Microwave News* that, "I think that what they did with the data they had was reasonable, but I would not go so far as to say that the problem is gone. I would like to continue surveillance."

The report promises to "continue to monitor the health of babies born to residents of Vernon" through the state Birth Defects Registry. In an interview, Dr. Mark Fulcomer, who wrote the report, said that, "The community deserves to have the work continued." For his part, Whartenberg favors a more detailed effort—a prospective epidemiological study.

The controversy surrounding the study is essentially a repeat of the 1984 dispute that arose when the NJDOH first tried to dismiss local fears of a birth defects problem in Vernon (see *MWN*, S84 and My85). The NJDOH was later forced to admit that its numbers were wrong—that there was a greater than expected incidence of chromosomal abnormalities among Vernon babies. The following year, the Centers for Disease Control confirmed the cluster and recommended that the NJDOH conduct the case-control study which it is now abandoning (see *MWN*, N/D85).

Three or Four Cases in 1987

In its December 1988 report, the NJDOH states that, "There is no continuation of the earlier increased rate of Down's Syndrome in babies born to residents of Vernon Township." Others, including Morton and CAT, disagree, arguing that the cluster continues to grow.

The critical year is 1987, when there were at least three cases—four cases, according to CAT—of babies born with chromosomal defects in Vernon. According to Morton's notes from the May 1988 panel meeting, the NJDOH said that there were two abnormal babies born in the first half of 1987: one case of Down's Syndrome and one case of translocation, another type of genetic abnormality. In addition, the amended minutes of the meeting acknowledged a further case of Down's Syndrome later in 1987. (The NJDOH report does not include a year-by-year breakdown of abnormal births.)

CAT's Elise Kreindler stated that there were three cases of babies born with chromosomal abnormalities in January 1987 alone. The third was a case of Trisomy 13, which is rarer than Down's and which is usually fatal. In addition, the case of gene translocation was extremely unusual—"A country-wide search failed to turn up a similar case," Kreindler said in a telephone interview from her new home in Florida. According to her records, at least two of the mothers were under 30 years of age when their babies were born with defects.

Including NJDOH's Down's Syndrome case from the second part of the year, Kreindler's total for 1987 rises to four.

On the average, there are fewer than 200 live births per year among women under the age of 31 in Vernon, according to NJDOH's statistics, and the expected rate of Down's Syndrome for this age group is approximately one per 1,000 live births. (Two other more serious abnormalities, Trisomies 13 and 18, together have an expected rate of only one in approximately 10,000 live births among women under 30.) Thus, the expected annual incidence of Down's and other serious genetic defects among young women in Vernon is approximately 0.2 cases per year.

"Clearly, if you look at the 1987 data, the cluster is continuing," said Dr. Robert Becker, a consultant to CAT based in Lowville, NY. In fact, Becker argued this very point in a letter to *Microwave News*: These new cases may "represent the beginning of a second peak in incidence" (see *MWN*, M/A88). Morton agrees, pointing out that such periodicity is consistent with reports of other epidemics.

When asked about the 1987 abnormal births, NJDOH's Fulcomer said that he did not want "to discuss the numbers," but added that three or four cases in a year would not be remarkable. Similarly, NJDOH's Ziskin did not respond to repeated requests for comment on the 1987 cases.

In the minutes of the May 1988 panel meeting, the NJDOH, while acknowledging two of the January 1987 cases, noted that it would not include its third recognized case in the study because it fell after the June 1987 cutoff date and the department chose not to "change the study period."

There is also a dispute about whether the NJDOH made a concerted effort to ascertain all of the cases of abnormal births. "The NJDOH did not try hard enough," Kreindler told *Microwave News*. "It's just plain criminal that they can know of this problem, but not do anything for seven years."

One longtime observer decried the way clusters have been

investigated. Dr. David Lilienfeld, an epidemiologist at New York City's Mount Sinai Hospital, told *Microwave News:* "The mishandling of the Vernon and other clusters in which the public is convinced that there is a health problem—whether there is one or not—leads to such suspicion and distrust in the public's mind that the agency is no longer able to fulfill its mandate. It's a major tragedy."

Microwave Radiation Levels

In 1987, the NJDOH asked the National Bureau of Standards (NBS) to evaluate two proposals to measure microwave radiation exposures in Vernon—one from Richard Tell, a consultant based in Las Vegas, NV, and one from Dr. Bill Guy of the University of Washington in Seattle. The NBS replied that the proposed methods would yield power density calculations with large uncertainties (on the order of 10-30 dB) and, thus, the "value of the proposed study [was] questionable."

But some members of NJDOH's advisory panel disagreed. In her comments to the NJDOH, Hatch argued that this conclusion seemed "well beyond the expertise of NBS." She strongly criticized the state for basing its decision to "jettison" the study on the NBS report without giving the panel the opportunity to meet with the NBS and review its findings.

In an October 28 letter to the NJDOH, Petersen pointed out that the accuracy of microwave measurements depends on the amount of money available, but that, "The cost of doing a useful assessment would far outweigh the benefit." He later stated that he was "satisfied with the state's conclusion that you cannot do an accurate assessment at a reasonable cost."

NCI EMF Study Questioned (continued from p.1)

of whom work at NCI, testified on behalf of the New York Power Authority (NYPA) in the $66.5 million Marcy-South power line lawsuit. In prepared statements, each discounted any cancer threat from EMFs (see *MWN*, J/A88 and S/O88). For instance, Sinks wrote 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."

For their contributions, Aaronson was paid $70,250.98, Sinks $41,083.42 and Tucker more than $12,978.04 (see *MWN*, N/D88.).

Similarly, NCI's Dr. Mark Israel is testifying on behalf of the Potomac Electric Power Co. (PEPCO) in an ongoing health effects hearing (see p.8).

Some of these NCI staffers are participating in a number of different proceedings across the country. For example, in 1988, Tucker gave evidence on behalf of the Mississippi Power Co., the Public Service Co. of Colorado, the Arizona Public Service Co. and PEPCO (see p.9).

The above-mentioned fees appear to be in violation of NCI rules. According to the National Institutes of Health's (NIH) rules on outside income, "Total compensation from consulting with profit-making organizations, including industry and law firms, and from testimony in private litigation, is limited to $25,000 per year, with no more than $12,500 from any individual company or law firm." (These rules were revised on September 1, 1988.)

In a December 29 letter to NIH Director Dr. James Wyngaarden, Dr. Ross Adey of the Veterans Administration Hospital in Loma Linda, CA, wrote that he and others "are deeply concerned that the RFP from NCI...comes from a source already committed by public statements of its senior scientists to an *a priori* position unequivocally denying the existence of a health problem." Adey raised the question of "excess" compensation and warned that, "At issue...is the safeguarding of an independent, objective and unbiased source of scientific expertise essential for framing wise public policies on highly technical issues that directly impact the public welfare."

Adey also sent copies of his letter to NIH to California Democratic Congressmen George Brown and George Miller.

As of January 25, the NCI had begun looking into Adey's allegations. An NCI spokeswoman told *Microwave News* that the investigation would take at least six weeks and that NCI scientists would not be available for comment.

The NCI EMF Study

The primary objective of the $2.5 million NCI study is to examine the association between specific subtypes of acute lymphocytic leukemia (ALL) among children and EMF exposure from power lines and residential appliances. Dr. John Boice of NCI's Radiation Epidemiology Division and Dr. Martha Linet of NCI's Epidemiology and Statistics Program are directing the study.

They will assess lifetime residential EMF exposure through visits to all current and previous residences of the ALL cases and of the matched controls in six mid-Western and mid-Atlantic states and through measurements taken at approximately 8,000 residences and 1,500 schools throughout the country. (The RFP asks for development of standardized protocols for obtaining and coding field measurements.)

NCI is also seeking proposals for an organization to act as the coordinating center for the study.

The EMF study is piggybacked onto a $2.35 million five-year study by the U.S. Children's Cancer Study Group of risk factors for childhood leukemia, which began in September 1988. The study, which also is being funded by the NCI, is headed by Dr. Leslie Robison of the University of Minnesota in Minneapolis.

For more information on the *Etiology of Childhood Leukemia: Measurement of Low Frequency Electromagnetic Fields*, RFP No.NCI-CP95608-21, and on the *Etiology of Childhood Leukemia: Coordinating Center*, RFP No.NCI-CP95610-21, contact: Barbara Shadrick, Cancer Etiology Contracts Section, NCI, Executive Plaza South, Rm. 620, Bethesda, MD 20892, (301) 496-8611.

CONFERENCES

New Listings

March 7-8: **American National Standards Institute (ANSI) Annual Public Conference on "The Future of the Voluntary Standards System: Challenges and Opportunities in the Post-Reagan Era,"** Grand Hyatt, Washington, DC. Contact: Development Department, ANSI, 1430 Broadway, New York, NY 10018, (212) 354-3300.

March 14-15: **MW Foods '89,** Drake Hotel, Chicago, IL. Contact: The Packaging Group Registrar, PO Box 345, Milltown, NJ 08850, (201) 636-0885.

April 10-14: **2nd International Conference on Frequency Control and Synthesis,** University of Leicester, U.K. Contact: Conference Secretariat, Institution of Electronic and Radio Engineers, Savoy Hill House, Savoy Hill, London WC2R 0JD, U.K., (01) 240-1871, ext. 246.

May 1-5: **Electrical Potpourri,** Electrical Power Research Institute (EPRI) Conference Center, Palo Alto, CA. Contact: Valerie Kakaio, EPRI, PO Box 10412, Palo Alto, CA 94303, (415) 855-2798.

May 8-12: **10th International Conference on Electricity Distribution,** Brighton Centre, Brighton, U.K. Contact: CIRED 1989 Organizing Committee, Conference Services, Institution of Electrical Engineers, Savoy Place, London WC2R 0BL, U.K., (01) 240-1871, ext. 222.

May 21-25: **Annual National Conference on Radiation Control,** Hilton Hotel, Baton Rouge, LA. Contact: Conference of Radiation Control Program Directors, 71 Fountain Place, Frankfort, KY 40601, (502) 227-4543.

June 18-22: **35th Annual International Education Seminar of the International Right-of-Way Association (IRWA),** Dearborn, MI. Contact: IRWA, 9920 La Cienega Blvd., #515, Inglewood, CA 90301, (213) 649-5323.

June 20-23: **4th National Environmental Health Conference,** San Antonio, TX. Contact: Centers for Disease Control, Atlanta, GA 30333, (404) 488-4700 or 488-4682.

August 21-23: **24th Microwave Power Symposium,** Westin Hotel, Stamford, CT. Contact: International Microwave Power Institute, 13542 Union Village Circle, Clifton, VA 22024, (703) 830-5588.

September 4-8: **19th European Microwave Conference,** Wembley Conference Centre, London, U.K. Contact: Microwave Exhibitions and Publishers Ltd., 90 Calverley Rd., Tunbridge Wells, Kent TN1 2UN, U.K., (08) 924-4027.

October 5-8: **National Convention of the Society of Broadcast Engineers (SBE),** Kansas City, MO. Contact: SBE, PO Box 16861, St. Louis, MO 63105.

October 20-21: **A Delicate Balance: Technics, Culture and Consequences,** California State University, Los Angeles, CA. A conference sponsored by the L.A. chapter of the IEEE's Society on the Social Implications of Technology. Contact: Dr. Nik Warren, Otis/Parsons Art Institute, 134 Hart Ave., Santa Monica, CA 90405, (213) 392-6595.

October 29-November 2: **Conference on Electrical Insulation and Dielectric Phenomena,** Xerox Conference Center, Leesburg, VA. Contact: Prof. Marshall Pace, Dept. of Electrical & Computer Engineering, University of Tennessee, Knoxville, TN 37996, (615) 974-5419.

November 28-December 1: **34th Annual Conference on Magnetism and Magnetic Materials,** Sheraton Boston Hotel, Boston, MA. Contact: Dr. John Scott, American Institute of Physics, 335 E. 45th St., New York, NY 10017.

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Conference Reports by C. Polk: Bioelectrochemistry (France) and Biomembranes (Bulgaria)

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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,

(continued on p.16)

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.

MICROWAVE NEWS is published bimonthly • ISSN 0275-6595 • PO Box 1799, Grand Central Station, New York, NY 10163 • (212) 517-2800 • FAX: (212) 734-0316 • Editor and Publisher: Louis Slesin, PhD; Senior Editor: Jennifer Goren; Assistant Editor: Matthew Connelly; Contributing Editor: Mark A. Pinsky; Copy Editor: Jim Feldman • Subscriptions: $250.00 per year ($285.00 Canada & Foreign, U.S. funds only); single copies: $50.00 • Copyright © 1990 by Louis Slesin • Reproduction in any form is forbidden without written permission.

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.