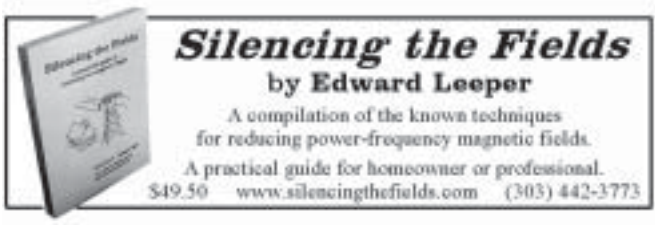
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UPDATES

MOBILE PHONE EMI

U.K. Tests Confirm Avionics EMI... Radiation from mobile phones produced "various adverse effects" in aircraft electronic equipment tested under controlled conditions, according to a report released by the U.K. Civil Aviation Authority (CAA) on April 30. Electromagnetic interference (EMI) caused navigation displays and indicators to give incorrect readings; made a gyroscopic compass freeze or indicate an incorrect bearing; and reduced the sensitivity of a radio receiver for the instrument landing system. In view of these findings, the CAA advises that the U.K. continue to ban the use of phones on aircraft once doors are closed in preparation for departure, and that carriers take additional preventive measures such as making sure that all phones in checked luggage are switched off. The CAA also recommends alerting the general aviation community to potential EMI hazards in small aircraft. In its testing, the CAA found that malfunctions could result from signals above 30 V/m — a level that can be produced by a mobile phone operating at maximum power and within 30 cm of sensitive equipment or its associated wiring. The tests covered 900 MHz GSM and 1700 MHz radiation, as well as 412 MHz signals from TETRA handsets. Most of the EMI problems were observed with 1700 MHz signals. Three years ago, the CAA reported that several phones operating simultaneously in the cabin of an aircraft produced readings as high as 4.5 V/m on the plane's flight deck — well above the 1 V/m standard for immunity from interference for older electronic equipment (see *MWN,* J/A00). Commercial airline crews have long suspected EMI from mobile phones or other electronic equipment to be the culprit in some malfunctions of navigation systems and other equipment (see, for example, *MWN,* S84, N/D88 and S/096). In its new report, the CAA notes that, from 1996 through 2002, crews reported 35 safety-related incidents citing mobile phones as a factor. *Effects of Interference from Cellular Telephones on Aircraft Avionic Equipment* is available at <www.caa.co.uk>.

PEOPLE

Thorne Auchter, who served as the administrator of OSHA during President Reagan's first term (1981-1984) and more recently as the chief operating officer of Dr. **George Carlo**'s consulting firm, Health & Environmental Sciences Group Ltd. (see *MWN,* S/O98), is now the CEO of Grace News Network. The GNN "is dedicated to transmitting the evidence of God's presence in the world today," according to information posted on its Web site, <www.gracenewsnetwork.com>....Dr. **Tom McManus** officially retired as the chief technical advisor of Ireland's Department of Public Enterprise at the end of last year, but he was pressed back into service on a temporary basis until a replacement is found. McManus told us that he will continue to represent Ireland on COST281. He is also a long-standing member of the executive committee of IEEE's ICES (SCC-28), but it is not yet clear whether his department wants to support his continued participation on this standard-setting committee (see also p.4)....Dr. **Gayle Woloschak** of the Northwestern University medical school in Chicago has been elected to the National Council on Radiation Protection and Measurements (NCRP), which is based in Bethes-

da, MD. Woloschak is also a member of the NRC panel investigating the potential health effects of the Air Force's PAVE PAWS radar on Cape Cod. Among those reelected to the NCRP are Dr. **John Boice Jr.** of the International Epidemiology Institute in Bethesda and **Susan Wiltshire** of JK Research Associates (emeritus) in South Hamilton, MA....On January 1, 2004, Dr. **Peter Boyle** will become the director of the International Agency for Research on Cancer (IARC) in Lyon, France (see *MWN,* M/A 03). Boyle, age 51, currently leads the Division of Epidemiology and Biostatistics at the European Institute of Oncology in Milan. He was a member of a team that discounted the leukemia risks associated with the Vatican RF transmitters in Cesano, outside Rome (see *MWN,* S/O01)....Prof. **Colin Blakemore**, the head of the Center for Cognitive Neuroscience at Oxford University, has been appointed the chief executive of the London-based Medical Research Council, the principal sponsor of biomedical research in the U.K. He takes over on October 1. Blakemore is a member of the National Radiological Protection Board's Advisory Group on Non-Ionizing Radiation and was a member of the Stewart panel on mobile phones. Last year he served as an expert witness opposing compensation in a case of two tower workers who claimed to have been overexposed to RF radiation (see *MWN,* S/O02)....Dr. **Charlotte Silverman**, an epidemiologist who worked at what is now known as FDA's Center for Devices and Radiological Health from 1968 to 1992, died of congestive heart failure on April 17. She was 89. She is a coauthor, with Dr. **Dennis Robinette** and **Seymour Jablon**, of the 1980 study on the potential effects of radar radiation on the health of navy personnel — the first of its kind. (See also p.15.) ...Dr. **Carl Sutton** died on April 12 in Tampa, FL, at the age of 73. Sutton retired from the Medical College of Wisconsin and the VA Hospital in Milwaukee in July 2001....Dr. **Neil Cherry** died in New Zealand on May 24 at the age of 56. He was diagnosed with motor neuron disease less than two years ago. Cherry was arguably the world's most active campaigner for tough EMF exposure limits. One of his last public appearances was testifying at the Newman brain cancer–mobile phone trial in Baltimore in February 2002 (see *MWN,* M/A02). Cherry, a meteorologist by training, was an associate professor of environmental health at Lincoln University in Canterbury.

RF ANIMAL STUDIES

NTP Study Moving Forward... On May 28, NIEHS toxicologist Dr. Ron Melnick hosted a meeting in Research Triangle Park, NC, to brief and to get feedback from the RF Interagency Work Group on the multimillion-dollar RF animal studies being planned by the National Toxicology Program (see *MWN,* M/J 01). "We are still planning to go ahead," Melnick told *Microwave News*. Under the current study design, rats and mice will be exposed to either 900 MHz or 1900 MHz microwaves in reverberation chambers that will allow unrestrained animals to be exposed for more than six — perhaps as many as twenty — hours a day. Among those present were representatives from EPA, FCC, FDA and NIOSH, as well as Dr. Perry Wilson of NIST in Boulder, CO, and Dr. Niels Kuster of IT'IS in Zurich, who are working on the dosimetry for the new project.

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Keeping Current: Follow-Up on the News

◆ The U.S. Court of Appeals in Richmond, VA, has delayed oral arguments in the Newman brain cancer–mobile phone lawsuit (see *MWN,* S/O02 and N/D02). Originally scheduled for June, they will be probably now held in late September, though at press time no date has been set.

◆ The *Wall Street Journal* (May 23) reports that EMI may have caused Patriot missile defense systems to shoot down a British fighter jet, killing its two pilots, and an American F/A-18 Hornet fighter during the Iraqi war. Analysts suspect that the Patriots, built by Raytheon, were placed too close together, causing their high-power radars to interfere with the systems' electronics.

◆ Officials in Zurich are measuring fields in schools and other buildings owned by the city to find out which transformers will have to be shielded to meet Switzerland's 10 mG precautionary limit for locations where people spend several hours or more a day (see *MWN,* J/F00). About 50 substations are located in or near schools, a spokesperson for Zurich's department of urban development told the *Neue Zürcher Zeitung* (April 15). The survey should be completed by the end of the summer.

◆ Papers from the WHO EMF project's workshop on *Adverse Temperature Levels in the Human Body,* held in Geneva last year (see *MWN,* J/F02), are available in a special issue of the *International Journal of Hyperthermia* (May-June 2003).

◆ In the May 1 issue of *Nature,* researchers report a new example of the potential significance of polarization in triggering biological effects: Male *Heliconius cydno* butterflies — found in Central American jungles — detect polarized light reflected by the wings of females of their species, and rely on these signals to locate prospective mates in the dappled shade beneath the forest canopy. (See also *MWN,* M/A00.)

◆ Recently published by the Neuromagnetics Group at Vanderbilt University in Nashville: *Magnetotherapy: Potential Benefits and Adverse Effects*. The 292-page collection of 15 papers is available for $45.00 from <magnetotherapy.spellgen.com>. Two of the papers, including a review of ELF EMF effects by Dr. Wolfgang Löscher, may be downloaded for free from this Web site.

VIEWS ON THE NEWS **Conflicts at BEMS Taint Research Agenda** *(continued from p.19)*

not, see p.10.)

WTR's $25-million research budget was by far the largest pot of money ever earmarked for RF research. It was squandered. The public is a loser because Carlo brought us no closer to understanding the health risks from cell phone radiation. BEMS suffered, too, and more directly. For close to a decade, its members were denied the chance to do the promised research.

Carlo's strategy was clever and effective. By dangling a huge amount of money in front of the cash-starved RF community, Carlo guaranteed silent obedience. Anyone who dared complain risked being cut off from his millions. There was the added benefit that scientists were discouraged from helping lawyers who were thinking about suing cell phone companies.

WTR's bank account is now empty, but BEMS still refuses to speak out — on behalf of its members or the public interest.

Donald Kennedy, the editor of *Science,* recently urged scientists to add their voices to public policy debates because they have knowledge others often lack (see p.15). Yet, BEMS is unable to admit that promises were made and broken, and that a huge amount of money disappeared with no accounting ever offered. Its members were cheated, but BEMS keeps silent.

The cell phone industry has never admitted that Carlo's WTR was a sham. If it did so, there might be calls for a real research effort. The reason BEMS is still unwilling to speak out appears to be that it, too, speaks for industry.

Support for this view comes in the March/April issue of the the *BEMS Newsletter,* in which our rebuttal should have been published. What appears to be a news item from a London conference is actually nothing more than industry propaganda. Nokia's Sakari Lang is cited as saying that the RF literature "does not support a need for studying nonthermal effects" and that there is "clearly" no necessity to do any more research on third-generation phone signals. If accepted, this would save the mobile phone companies millions. No other view is offered.

And in the same item, Eleanor Adair, now retired from the U.S. Air Force, is reported to have decried "shoddy" RF experiments that were "more like entertainment than science." Here again, Motorola's Swicord, the editor of the newsletter, saw no need to offer any specific examples or any opposing opinions.

Not long ago, the *BEMS Newsletter* devoted a page and a half to the opinions of five Swedish scientists — none of them members of the society — who trashed other Swedish researchers for daring to publish research which suggests that mobile phones might present a health risk. Someone went to the trouble of translating the text from the original Swedish, but no one thought of giving those who were attacked a chance to respond, even though one of them was a former president of BEMS.

BEMS seems willing to promote corporate ideas, even when they could drive the society into bankruptcy. Last year, BEMS, feeling the pinch of deteriorating finances and declining membership, issued a strategic plan. Here is the closing thought: "The long-range plan might have to include an exit strategy."

Maybe this was BEMS' strategy all along: Give industry and the military control of the research agenda and, when the inevitable stagnation follows, quietly turn off the lights and lock the door.

In late June, BEMS will hold its annual meeting in Hawaii and celebrate its 25th anniversary. Maybe some of those who are committed to science will take a break from the festivities and take control of their society.

Corporate Conflicts at the Bioelectromagnetics Society Taint Research Agenda

Bioelectromagnetic research should be exciting. It is, after all, about one of the most basic questions in biology: How do electromagnetic signals affect us?

Instead, it is mostly about politics, often nasty politics. One side says the radiation is nothing more than a source of energy and, at high enough levels, can heat us up. Otherwise, the question is not worth thinking about. This is — no surprise — the position of industry and the military, who don't want any restrictions on their use of the radiation.

Others counter that we are, by our very nature, electromagnetic beings, and it is highly likely therefore that some types of signals will have some types of effects.

This argument has been raging for 30 years — without resolution.

The Bioelectromagnetics Society was founded in the late 1970s to bring the two sides together and to get some answers. That mission has failed because BEMS is an organization at war with itself. The society has been so co-opted by special interests that it is now ambivalent about doing research. Many of its members aren't even excited by experiments that presage scientific breakthroughs.

Take, for example, a series of recent animal studies which suggest that RF/MW radiation can actually protect against the development of cancer (see *MWN*, S/O02). These were chance findings and remain somewhat fuzzy, but they are certainly fascinating. What could be more rewarding than identifying those electromagnetic signals that can delay, or even prevent, cancer? Yet, you would never know it by hanging out at at a BEMS meeting. One hardly ever hears a word about these experiments within the society. Why isn't BEMS interested?

The simple answer is that most members of the society still will not look beyond the thermal dogma. At BEMS, scientific curiosity takes a backseat to economic and political imperatives.

BEMS was created by the U.S. military. Today, the mobile phone industry is the major force within the society. Not long ago, it was the power companies, but they are taking a more relaxed approach now that their campaign to write off the EMF–cancer link has been so successful. Motorola alone has eight staff members in the society, more than from all the American electric utilities combined.

A disagreement between BEMS and *Microwave News* provides a good example of how vested interests keep BEMS from promoting research. A recent issue of the *BEMS Newsletter* featured an attack on *Microwave News* by two Motorola consultants. Asher Sheppard, a past president of BEMS, and Q. Balzano, a runner-up for the presidency a few years earlier, took offense at what we wrote about one of their recent papers. Instead of taking the matter up with us, they turned to BEMS, where Motorola's Mays Swicord runs the newsletter.

We submitted our response, but BEMS refused to print it because, we were told, we wrote that George Carlo's Wireless Technology Research (WTR) had run a confidence game on behalf of the mobile phone companies. Our point is that Carlo and the industry he represented never wanted to do any actual research. This is, in fact, the majority view within BEMS — even among those in industry, if asked in private. (We are publishing the full text of our response because the BEMS leadership would

(continued on p.18)

WHO Do You Trust?

We admit it, we got sucked in. We believed what most of those who were at the February WHO workshop told us: Michael Repacholi has accepted a precautionary approach to EMF health risks.

Repacholi now says that it was all a misunderstanding. He was only floating a trial balloon to provoke discussion (see p.1). The EMF project is instead devising a framework for applying the precautionary principle to all types of environmental risks, something many others have already done.

It's the usual Repacholi doubletalk — not unlike when he tried to convince us that exposure to power line EMFs, like drinking a cup of coffee, might be good for our health (see *MWN*, N/D02).

What makes Repacholi's latest flimflam especially cynical — some would say hypocritical — is that invoking the precautionary principle does not require any specific action. It is a symbolic act that simply puts the public on notice about an uncertain risk.

Repacholi is sending a different message: Industry can be confident that he will fend off precautionary policies.

What's he up to? The only thing we can think of is that he is positioning himself as industry's candidate to become the WHO honcho on the precautionary principle. If he succeeds, he would be Geneva's replicant of John Graham, the Bush Administration's czar for regulatory reform, who recently said: "We consider [the precautionary principle] to be a mythical concept, perhaps like a unicorn."

Memo to Dr. Jong-Wook Lee, the incoming head of the WHO: It's time to clean house.

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PEMFs and Chick Eggs: Results Mixed, Mechanism Elusive

A consistent picture of the effects of weak pulsed electromagnetic fields (PEMFs) on developing chick embryos continues to elude researchers. PEMFs have been found to be biologically active in Finland but not in Sweden — perhaps because the PEMFs and exposure conditions were different. Researchers are also at work in the U.S. and in Belgium using more complex PEMF waveforms.

Looking at all the studies completed to date, there is no agreement on the mechanism of PEMF action (see also *MWN*, March 1983, June and December 1984 and January/February 1986). Current hypotheses include (1) direct action of the magnetic and/or the electric field, (2) an effect dependent on the time rate of change of the magnetic field and, of course, (3) the possibility that the positive results are artifacts.

Juutilainen in Finland

Jukka Juutilainen and coworkers have shown that PEMFs can cause significant abnormalities in chick eggs; the results point to a direct magnetic field effect, with a threshold at about 1 A/m (1.2 uT) for fields above 30 Hz.

Juutilainen, who is at the Department of Environmental Hygiene at the University of Kuopio in Finland, has been studying PEMFs for about five years and began working with chick embryos three years ago, after Delgado's group published its first findings.

(continued on p.10)

EPA Issues RF/MW Options

On June 12, the Environmental Protection Agency (EPA) released four options for regulating general population exposures in the 10 kHz to 100 GHz frequency range. Following publication in the *Federal Register*, the options will be subject to a 90-day public comment period; a public meeting will be held in Washington, DC, during that time.

As described in our January/February issue, the EPA is proposing power density limits of 100, 200 or 1,000 uW/cm² — or no regulatory action at all. Two years ago, the agency was set to propose a 100 uW/cm² limit but backed off in the face of intense opposition from the EPA's policy office (see *MWN*, June and July/August 1984).

The radiofrequency and microwave (RF/MW) options were cleared by the Office of Management and Budget in January but were delayed when EPA Administrator Lee Thomas coordinated the U.S. response to the Chernobyl nuclear accident.

HIGHLIGHTS

Research on ELF-Cancer Link Intensifies

The literature on the relationship between exposures to extremely low frequency (ELF) fields and cancer continues to grow. Here are the latest results.

Occupational Trends

Combining data sets from 11 different epidemiological surveys, Drs. David Savitz and Eugenia Calle discern an "enhanced" risk of acute myeloid leukemia (AML) and a "modest" risk of all leukemias among some types of electrical workers.

In a paper scheduled to appear in the *Journal of Occupational Medicine,* they report that telegraph, radio and radar operators have 2.6 times the risk of AML, as well as a twofold increased risk of acute leukemia, compared to other workers. Power and telephone linemen are also more likely to develop AML, and aluminum workers and power station operators have a greater risk of getting acute leukemia.

The overall relative risk for all workers with potential exposures to electromagnetic fields was 1.5 for acute myeloid leukemia, 1.4 for acute leukemia and 1.2 for all types of leukemia. Savitz, of the University of North Carolina's School of Public Health in Chapel Hill, and Calle, of the Centers for Disease Control in Atlanta, GA, were struck by the "consistency" of the elevated cancer risk among these occupations.

The observed excess may be due to occupational factors other than ELF fields or to some confounding variable, Savitz explained in a telephone interview. On the other hand, the lack of quantitative exposure data coupled with the inclusion of many unexposed individuals could dilute what might be a much higher risk. As Savitz and Calle explain in their paper: "If there really is an association . . . [it] would have to be substantial to account for the modest positive results which have been reported." (See also *MWN,* March/April 1986.)

Unexpected Finding Among Shipyard Workers

Another tie between ELF and cancer among naval shipyard workers has surfaced rather unexpectedly. A large team led by Frank Stern of the National Institute for Occupational Safety and Health was studying the possible association between leukemia deaths and exposures to ionizing radiation or solvents. No such link was found but the researchers did detect a significant excess of leukemia among electricians and electrical welders. Electricians had sixfold and threefold increased risks of lymphatic leukemia and all leukemias, respectively. Welders had a significantly elevated risk (nearly four times the expected rate) of myeloid leukemia, but not for all leukemias. The study results are presented in the June 1986 *American Journal of Epidemiology, 123,* pp.980-992.

Inconsistent Swedish Results

An ongoing series of studies by Swedish researchers at the National Board of Occupational Safety and Health (NBOSH) and at the National Institute of Environmental Medicine in Stockholm continues to yield inconclusive and erratic results.

The latest paper – by a team led by NBOSH's Dr. S. Tornqvist – shows that power linemen had a slightly elevated risk of leukemia and brain tumors but that power station operators had *normal* cancer rates. In contrast to other studies, none of the workers were found to have an increased risk of any particular type of leukemia.

An unexpected risk of kidney and other urinary cancers was found in both groups, but the researchers did not attempt to explain this result, except to say that both groups were exposed to chemicals on the job.

As in the Savitz-Calle study, the authors point out that study participants with little or no ELF exposure may mask a larger effect among those who are more heavily exposed. The Swedish paper appears in the *British Journal of Industrial Medicine, 43,* pp.212-213, 1986.

Tomenius Paper Published

Dr. Lennart Tomenius, a former health officer in Stockholm, Sweden, has published his study that supports Dr. Nancy Wertheimer and Ed Leeper's observed link between childhood cancer rates and magnetic fields from ELF sources, primarily power lines. Tomenius's results on 50 Hz fields in Stockholm, which were first reported in 1982 (see *MWN,* November 1982), appear in the most recent issue of *Bioelectromagnetics, 7,* pp.191-207, 1986.

In a review paper, Dr. Kazim Sheikh of the University of Michigan School of Public Health in Ann Arbor criticizes past occupational and population ELF studies for their lack of adequate exposure assessments and for their failure to establish dose-response relationships or latency periods. Writing in the *Archives of Environmental Health, (41,* pp.56-63, January/February 1986), he emphasizes the need for further research before accepting or rejecting the hypothesis that ELF fields are leukemogenic.

Major Study Planned in Canada

It is very likely that a large-scale epidemiological study of the possible link between ELF fields and leukemia (and cancer in general) will begin later this year in Canada.

Hydro Quebec's Dr. Michel Plante told *Microwave News* that there is about an 80 percent chance that the project will be approved in August following the review of a feasibility study. Plante explained that the cancer study was requested by the Quebec government after a public hearing in 1983.

Dr. Gilles Theriault of McGill University's School of Occupational Health in Montreal will soon forward his feasibility study to the utility company. In an interview, he said that the full-scale study, if and when completed, should provide "a definitive answer" to the question of cancer risk.

To gauge individual exposures, Hydro Quebec engineers have designed a small, portable monitor capable of measuring ELF fields once a minute for two weeks.

NCRP Recommends 200 uW/cm² RF/MW Population Limit

The National Council on Radiation Protection and Measurements' (NCRP) long-awaited report on radiofrequency and microwave (RF/MW) radiation has been published and, as expected, it recommends a 200 uW/cm² standard in the 30-300 MHz band for the general population. The standard covers the 300 kHz to 100 GHz frequency range.

For occupational exposures, the NCRP recommends the same limits as those adopted by the American National Standards Institute (ANSI) in 1982. But for the public, the NCRP wants a standard stricter than ANSI's by a factor of five. Dr. Bill Guy of the University of Washington in Seattle chaired both the NCRP and ANSI standards-setting committees.

In its report, the NCRP explains that the limit for the public is one-fifth that for workers because the ratio of the number of hours in the average work week (40) to the total number of hours in a week (168) is approximately 0.2. Asked at the NCRP's annual meeting in Washington, DC, in early April, why the committee did not apply the more commonly used safety factor of ten to convert an occupational standard to a population standard, Dr. Edward Alpen of the University of California in Berkeley, a member of the NCRP committee, replied that it would be "gross overkill," adding that the committee thought the 1 mW/cm² standard was already conservative.

The time-averaging provision for public exposures is more lenient than that for workers, however. For population exposures, the recommended limits are averaged over a 30-minute interval, while occupational exposures are averaged over six minutes.

Special Precautions for Modulated Fields

One original aspect of the NCRP recommendations is the provision that, "If the carrier frequency is modulated at a depth of 50 percent or greater at frequencies between 3 and 100 Hz, the exposure criteria for the general population shall also apply to occupational exposures." This added precaution is based on calcium efflux research by Dr. Ross Adey of the VA Hospital in Loma Linda, CA, which has been confirmed by Dr. Carl Blackman of the Environmental Protection Agency. Adey was a member of the NCRP RF/MW committee.

The NCRP report notes that while it is not known whether the biological effects of low frequency modulation pose a health risk, "their reliability and their independent confirmation in avian and mammalian species dictate the need for caution."

No special precautions are recommended for pulsed radiation because of "limited data."

Effects To Watch

The NCRP report took nine years to complete and is based only on research published through 1982. Nevertheless, the committee took special note of two more recent findings, which, it advises, could result in a tightening of the exposure guidelines in the future:

- The risk of RF shocks and burns at frequencies above 1 MHz, based on the research of Drs. Om Gandhi of the University of Utah in Salt Lake City and Bill Guy (see *MWN*, July/August 1985).
- The possible link between exposures to RF/MW radiation and the increased incidence of cancer indicated in the first long-term, low-level exposure study, which was carried out in Guy's lab in Seattle (see *MWN*, July/August 1984 and March 1985).

The 353-page NCRP report, *Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields* (No.86), includes 63 pages of references. It is available for $20.00 from NCRP Publications, 7910 Woodmont Ave., Suite 1016, Bethesda, MD 20814, (301) 657-2652. (See also *MWN*, January/February 1986.)

Radio Technician's Widow Sues Over RF Exposure

A Kentucky woman whose husband died of leukemia after working 22 years as a radio technician has sued the manufacturer of an FM transmitter system for failing to protect him from, or to warn him about, the health risks associated with exposure to radiofrequency (RF) radiation.

In a civil suit filed May 1, Marie Lafferty stated that, "The radiation to which [William Lafferty] was exposed while working in the intended manner on and near the equipment was of such a level as to be the proximate cause of his death." The suit against Collins Radio Co., a subsidiary of Continental Electronics Manufacturing Co., Inc. (both in Dallas, TX), asks for an unspecified amount of money for Mr. Lafferty's death, for punitive damages and for mental harm and other injuries to Mrs. Lafferty and the couple's two sons.

William Lafferty died at age 41 of acute myelomonocytic leukemia on August 11, 1983, approximately a month after his doctor diagnosed the disease. Mrs. Lafferty contends in her complaint that this type of leukemia is "known in the medical profession to result from exposure to high quantities of RF radiation." Mr. Lafferty was in good health until 1983, when he began to complain of a "burning or boiling sensation internally and on the surface of his skin," according to the court papers.

Lafferty maintained and repaired the equipment for WQHY-FM (95.5 MHz), one of two stations owned and operated by WDOC, Inc., of Prestonsburg, KY; on at least some occasions, he worked on the station's tower while it was broadcasting. In 1981, Collins Radio Co. upgraded WQHY's antenna and transmitter.

Mrs. Lafferty first suspected that her husband's death was due to RF radiation exposure when she learned in 1985 that the Environmental Protection Agency (EPA) had identified the WQHY site as one of approximately 200 in the U.S. where RF levels in publicly accessible areas exceeded the American National Standards Institute's (ANSI) exposure guidelines (see *MWN*, January/February 1985). In a telephone interview, she told *Microwave News* that her oldest son sometimes went to the station with his father and returned home dizzy. "There is something going on," she said. "I have got to know why my husband died."

As we go to press, attorneys for Collins Radio Co. have asked the Floyd Circuit Court to move the case to federal court. C.V. Reynolds, the attorney representing Lafferty, said in an interview from his office in Prestonsburg that he expects the court to approve the request. Stuart Lemle of the Washington, DC, law firm of Land & Lemle is co-counsel for Mrs. Lafferty.

Collins is represented by Linda Hopgood of the Lexington, KY, firm of Clark, Ward, Stuart & Hopgood; Continental Electronics is represented by Mike Schmitt of the Paintsville, KY, firm of Wells, Porter, Schmitt & Walker.

FCC Drops FM-Aircraft EMI Rules

The Federal Communications Commission (FCC) has suspended plans to develop criteria to ensure compatibility between FM broadcasts and aircraft navigation and communication systems. The commission concluded that there is insufficient information to continue work on the rules it proposed in April 1985 (see *MWN*, May 1985).

The Federal Aviation Administration (FAA), which opposed the FCC's rulemaking proposal, will continue to work with the FCC on electromagnetic interference (EMI) problems on a "case-by-case" basis, the FAA's Gerald Markey told *Microwave News*. John Wong, chief of the FCC's Engineering Policy Branch, confirmed that the commission will continue to investigate reported cases of interference.

In its *Memorandum Opinion and Order* closing the proceeding, the FCC stated that although the 12 sets of comments submitted on its proposal "raised significant concerns about the aeronautical interference issues, they did not provide enough substantive information from which final rules could be adopted." In addition, the order noted that a panel of the International Radio Consultative Committee (CCIR) plans to review the FM-aeronautical EMI problem later this year. The FCC concluded that final action at this time would be "premature" and advised that it will consider taking up the issue again after the CCIR group meets.

Markey, acting manager of the FAA's Spectrum Engineering Division, said that the FCC's decision does not alter his agency's position that broadcasters, rather than airlines, should bear the burden of ensuring compatibility. The FAA contends that low power avionics signals are simply overpowered by broadcast transmissions. The FCC suggested in its April 1985 proposal that poor receiver design was a major cause of EMI.

Markey added that he believes the FCC issued its proposal at least partly to force the FAA to move up the effective date of its rules requiring improved immunity in avionics receivers. Those rules are scheduled to take effect in 1995, and the agency has no plans to alter its schedule.

Wong responded that the FCC was not trying to pressure the FAA: "We had been receiving complaints from broadcasters." He added that both broadcasters and airlines bear unnecessary burdens as the situation stands.

While the increasing risk of EMI prompted the FCC's proposal, both sides agree that no accidents have been caused by interference. FM radio broadcast frequencies at 88-108 MHz abut aircraft very high frequency (VHF) systems at 108-137 MHz. The FAA's Markey said that television broadcasts can also cause interference, although the FCC excluded both TV and AM transmissions from its 1985 proposal. In addition, though the FCC contends that only general aviation, and not commercial, airplanes face a potential risk, the FAA says that all planes can be affected.

FCC Seeks Comments on Federal Preemption of RF/MW Standards

Reacting to continuing pressure from the broadcasting industry, the Federal Communications Commission (FCC) is now seeking public comments on the impact of state and local radiofrequency and microwave (RF/MW) radiation safety standards.

In response to the National Association of Broadcasters' (NAB) latest petition asking for federal preemption (see

Naval EMC: Incompatibility Sinks Ship

The lack of electromagnetic compatibility (EMC) led to the sinking of a British destroyer by an Exocet missile during the 1982 Falklands War with Argentina. Radar and electronic countermeasures which could have protected the H.M.S. Sheffield were temporarily jammed by the ship's satellite communications system. Twenty crew members died in the attack.

The Daily Mirror, a London tabloid, featured this story in a series of front page articles in mid-May, reporting that a telephone call from the Sheffield's captain had rendered its anti-missile radar system useless. The Ministry of Defense confirmed the story: a spokesman said that the Royal Navy had taken steps to prevent a repetition of the incident.

Dr. Robert Haislmaier, the EMC coordinator for the U.S. Navy, told *Microwave News* that he knew about the Sheffield incident, and that, since learning about it, his staff has taken an even closer look at potential compatibility problems. Incidents like this, he said, are the reason we have an aggressive EMC control program in the Navy.

The Associated Press picked up the Sheffield story, which then ran in the May 16 *Washington Post* and *New York Times*, even though it had already been reported in a book on the Falklands war: Military historian Martin Middlebrook described how the Sheffield's SCOT satellite communications system was used to send "routine messages in what appeared to be a quiet period" and that they "automatically blotted out the particular radar frequencies" used by the Exocet missiles. Middlebrook's *Operation Corporate: The Story of the Falklands War, 1982* was published last fall by Viking-Penguin in London.

MWN, March/April 1986), the commission issued a Public Notice on May 1, asking for information concerning "the extent to which state and local RF radiation standards have or have not adversely affected communications services by imposing unreasonable burdens, economic or otherwise, upon permittees and licensees."

Several earlier NAB pleas for preemption have been rejected by the FCC. (See *MWN*, September 1982, April and September/October 1985.)

Comments on the NAB petition must be filed no later than August 1 and reply comments are due by September 1. For more information, contact the FCC's Joseph McBride, (202) 254-6530.

The Electromagnetic Energy Policy Alliance (EEPA) has already submitted a 3-page letter in support of the NAB petition.

RF Lighting: FCC Proposes Radiated Limits Below 30 MHz

The Federal Communications Commission (FCC) has proposed limits for radiated emissions from radiofrequency (RF) lighting devices below 30 MHz to protect against interference to AM and other broadcasters.

According to the commission, the proposed radiation limits for RF lights are based on those applied to other RF devices that can cause harmful RF interference (RFI) below 30 MHz: For 9-450 kHz: 2.4/F uV/m at 300 meters; for 450 kHz-1.705 MHz: 24/F uV/m at 30 meters (where F is in MHz); and for 1.705-30 MHz: 15 uV/m at 30 meters.

The commission expressed ambivalence as to whether radiated RFI rules are necessary, however. In its proposal, released on May 8, the FCC invited comments, particularly with respect to whether limits "below 30 MHz are, in fact, needed or if our present conducted limits below 30 MHz are sufficient to mitigate our interference concerns."

Consumer RF lighting devices will continue to fall under the commission's certification requirements, while non-consumer devices need only meet verification requirements. Under certification, manufacturers must submit test data to the FCC, while under verification, they retain their test data.

FCC Rejects NAB Petition

When it revised its rules for industrial, scientific and medical (ISM) equipment – including RF lighting devices – last September, the FCC did not set a standard to limit radiated interference below 30 MHz. The National Association of Broadcasters (NAB) responded immediately by petitioning the commission to reconsider: it specifically asked for an emission limit of 25 uV/m at 10 meters (see *MWN*, September/October 1985). On the same day that it proposed the new RF lighting rules, the FCC denied the NAB's petition.

In its current proposal, the FCC rejected the limits requested by the NAB, stating that it agreed with the National Electrical Manufacturers Association (NEMA) that the NAB's measurement techniques are not sufficiently sophisticated to justify a 25 uV/m limit.

Summaries of both the FCC's proposal and its denial of the NAB petition appear in the May 16 *Federal Register*, 51 *FR* 18004 and 17970, respectively. Comments on the FCC's proposal are due on June 30 and reply comments are due on July 15. For more information, contact Liliane Volcy at the FCC's Office of Engineering and Technology, (202) 653-7316.

NAS-NRC on Non-Thermal Effects

An advisory committee to the National Academy of Sciences-National Research Council (NAS-NRC) has acknowledged the existence of non-thermal effects due to non-ionizing radiation but has reserved judgment on their health hazards.

Following a one-day meeting at which Drs. Ross Adey, Glenn Edwards, Reba Goodman and Nancy Wertheimer, among others, described their research on low-level effects (see *MWN*, November/December 1985), the Advisory Committee on the Non-Thermal Effects of Non-Ionizing Radiation reported 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."

In its report to the NAS-NRC's Board on Radiation Effects Research (BRER), the committee noted that the research raises "important scientific questions in the areas of developmental biology, neural function, dosimetry and mechanism. To answer these questions and to assess their implications for potential health hazards will require high quality research, fastidious reporting and independent replication of experiments."

The committee, which was chaired by Dr. Robert Hofstadter of Stanford University in Stanford, CA, also recommended that human epidemiological studies be replicated and extended, that collaborative research with scientists outside the non-ionizing radiation community be encouraged and that funding agencies use "reviewers with a broader vision and a more critical approach than seems to be currently the case."

Dr. Stephen Brown, staff officer of BRER, told *Microwave News* that the board has decided not to pursue the non-ionizing radiation issue actively for the present time, but that it will continue to track developments. Brown recently left the NAS-NRC to join ENVIRON, a Washington, DC, group, to work on chemical risk assessment. Dr. Bill Ellett will take over as BRER's staff director. Ellett, who has been at the NAS-NRC for about 18 months, used to work at the Environmental Protection Agency's Office of Radiation Programs.

Summary

Reprinted below is a summary of the committee's report:

- Bioelectromagnetics research has produced abundant reports of a wide variety of individual biological responses to low-level non-ionizing radiation. At least three mechanistic biophysical theories have been offered to explain how non-thermal interactions could develop. However, the connections among the various experimental findings and the theoretical constructs do not lead to a comprehensive conceptual structure for the reported phenomena sufficient to enable an evaluation of the significance of the theories.
- Few bioelectromagnetics experiments have been exactly and independently replicated. At this point in the development of the field,

it may be more important to replicate some key experiments with simple and well-characterized systems than to generate entirely new experimental designs. Experiments that impose specialized and restricted conditions should probably be avoided.

• To give meaning to the bioelectromagnetic observations that can or will be replicated will require a comprehensive theory for the mechanisms of action. Several complementary or competing mechanistic theories have been proposed. Some are descriptive, others are phenomenological, and a few invoke fundamental biophysical principles and are quantifiable. With a few exceptions, however, these theories have not been used to generate critical, experimentally verifiable predictions, and thus remain largely speculative. The cycle from theory to hypothesis to prediction to experimental test of prediction to modified theory needs to be rigorously followed.

• To see that sufficient emphasis is given to replication and investigation of mechanisms, adoption of stringent procedures for reviewing grant proposals and administering contract research programs will be necessary. Special attention should be given to ensuring full consideration and reporting of uncertainties derived from both systematic and statistical errors.

• Infusion into bioelectromagnetics research of expertise from other fields may prove desirable. Such enrichment might come about through using consultants to assist in ad-hoc review panels and arranging for a pool of potential collaborators and highly regarded research teams with strengths complementary to those already represented within the field.

A limited number of copies of the report, *Non-Thermal Effects of Non-Ionizing Radiation,* are available free from the Board on Radiation Effects Research, NRC, 2101 Constitution Ave., NW, Washington, DC 20418.

Electric Blankets Linked to Fetal Loss

Pregnancies among couples who use electric blankets (EBs) are more likely to end in miscarriages than those among couples who do not heat their beds electrically, according to a recently published study by Dr. Nancy Wertheimer and Ed Leeper, of the Department of Preventive Medicine and Biometrics at the University of Colorado Medical School in Boulder. In general, their findings also indicate a trend toward slower fetal development among babies born to parents who use EBs or water beds (WBs).

Wertheimer and Leeper, who are well-known for their studies linking power line fields with cancer, observed a clustering of spontaneous abortions from September to June among EB users — the period of greatest reliance on electrically-heated beds. For those who rely on either EBs or WBs, the miscarriage rate was significantly higher during the September-January period. No such seasonal pattern was observed among non-users.

Fetal growth rates may be affected by EBs and WBs: the study showed that infants conceived during the winter months had significantly longer gestation periods and were more likely to be "slow-growing" — defined as having a below-median weight despite an above-median gestation period — than those conceived during July and August. Wertheimer and Leeper explain in their paper that these patterns "may represent a successful compensation for some effect of [EB] or [WB] use, which temporarily retards *early* development " (their emphasis).

In an interview with *Microwave News,* Wertheimer offered the following overview: "The results of this study could be attributed to either electromagnetic field exposure or to excessive bed-heating. However, our ongoing research suggests that the field exposure is important."

The study, first presented at the New York Academy of Sciences in 1984 (see *MWN,* May 1984), has now been published in *Bioelectromagnetics, 7,* pp.13-22, 1986.

Exposures Estimated

EBs and WBs generate extremely low frequency (ELF) electric and magnetic fields — the electric fields have been better studied.

For instance, researchers at Carnegie-Mellon University in Pittsburgh, PA, have constructed theoretical models to estimate the electric fields associated with EBs and WBs. At the 1985 Bioelectromagnetics Society meeting, Keith Florig, a graduate student in the Department of Engineering and Public Policy, presented an EB model, predicting that, for an *ungrounded* individual, a maximum local surface field of 4.9 kV/m occurs when the current is on. In his WB model, the maximum field is about 0.1 kV/m when the current is *off.*

High electric field exposures can occur even when the current is off, according to Florig, because there is a 50 percent chance that the EB or WB is plugged into the "hot" side of the outlet. Therefore, even though the unit is switched off, the heating element is at 115 V and is generating ELF electric fields — but not magnetic fields, since there is no current flowing. Polarized plugs would ensure that EBs are at ground potential, rather than at 115 V.

In the unlikely event that the individual is grounded and the heater is plugged in and at 115 V, the local electric field can be as high as 16 kV/m for EBs and 20 kV/m for WBs, Florig recently told *Microwave News.* If the person is not grounded, the exposure from EBs drops off considerably — to 0.3 kV/m.

Florig will present a revised version of his 1984 data at this July's summer meeting of the IEEE Power Engineering Society in Mexico City. His paper will be published in a forthcoming issue of the *IEEE Transactions on Power Delivery.* (A copy of Florig's paper is available for $3.00 for IEEE members, $6.00 for others, from IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854: Order No.86-SM410-5.)

Mike Silva of Enertech (also in Pittsburgh) has measured human exposures from EBs for the Electric Power Research Institute (EPRI) and his preliminary data generally agree with those from Florig's models. Silva also found that the worst case exposure occurs when a grounded individual is under an EB which is turned off but at 115 V. Speaking at the 1984 EPRI contractors meeting in St. Louis, he said that he was in the process of developing a computer model of the magnetic fields associated with EBs.

Some of Silva's preliminary data are in his interim EPRI report, *AC Field Exposure Study: Human Exposure to 60 Hz Electric Fields,* (No.EPRI EA-3993, April 1985). Silva writes that in 1978 there were more than 51 million EBs in use and that in 1981 five million EBs were sold in the U.S.

EPRI's Dr. Robert Patterson told *Microwave News* that Silva's more recent measurements will be published next year.

CONFERENCES

New Listings

August 18-22: **5th Annual Society of Magnetic Resonance in Medicine Meeting,** Montreal Convention Center – Palais des Congres de Montreal, Quebec, Canada. Contact: Society of Magnetic Resonance in Medicine, 15 Shattuck Square, Suite 204, Berkeley, CA 94704, (415) 841-1899.

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

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

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

September 24-26: **Physiological NMR Spectroscopy from Isolated Cells to Man,** Vista International Hotel, New York, NY. Contact: Conference Director, New York Academy of Sciences, 2 East 63rd St., New York, NY 10021.

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

November 2-6: **1986 IEEE Conference on Electrical Insulation and Dielectric Phenomena,** Hilton Hotel, Claymont, DE. Contact: Roy Wootton, 501-3W57, Westinghouse R&D Center, 1310 Beulah Rd., Pittsburgh, PA 15235, (412) 256-2108.

November 10-12: **RF Expo East,** Marriott Copley Place, Boston, MA. And February 11-13, 1987: **RF Technology Expo 87,** Disneyland Hotel, Anaheim, CA. Contact: James MacDonald, RF Technology Expo, 6530 S. Yosemite St., Englewood, CO 80111.

November 17-20: **1986 DOE-EPRI Contractors Review: Biological Effects of Electric and Magnetic Fields,** Sheraton Denver Tech Center, CO. Contact: W/L Associates, 600 S. Frederick Avè., Suite 401, Gaithersburg, MD 20877, (301) 948-0642.

Upcoming Meetings

July 20-25: **Summer Meeting of the IEEE Power Engineering Society (PES),** Mexico City, Mexico. Contact: IEEE Society Special Services, IEEE, 345 East 47th St., New York, NY 10017, (212) 705-7893.

July 28-30: **21st Annual Microwave Power Symposium,** Crowne Plaza Hotel, Memphis, TN. Contact: International Microwave Power Institute (IMPI), 13542 Union Village Circle, Clifton, VA 22024, (703) 830-5588.

July 30-August 3: **1986 International Tesla Symposium,** Colorado College, Colorado Springs, CO. Contact: IEEE Pikes Peak Section, Suite 115, 330-A West Uintah, PO Box 150, Colorado Springs, CO 80901.

August 15-16: **International Symposium on Recent Advances in Microwave Technology and Future Challenges,** University of North Dakota, Grand Forks, ND. Contact: Banmali Rawat, Dept. of Electrical Engineering, Box 7165, University of North Dakota, Grand Forks, ND 58202, (701) 777-4331.

August 20-22: **11th Annual Conference of the Australian Radiation Protection Society,** Sydney, Australia. Contact: D.A. Woods, Office of the Supervising Scientist, PO Box 387, Bondi Junction, NSW 2022, Australia, (02) 387-0666.

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

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

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

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

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

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NMR Imaging Health and Safety: An Annotated Bibliography

Summarized below are some recent papers and conference abstracts on the health effects, interference to ferromagnetic and medical devices and site planning problems associated with nuclear magnetic resonance imaging (NMRI). These listings are excerpted from a forthcoming Microwave News *report available for $18.95 (prepaid) from PO Box 1799, Grand Central Station, New York, NY 10163.*

(Note: B = magnetic field; dB/dt = time-varying magnetic field; F.R.G. = Federal Republic of Germany; G = gauss; SAR = specific absorption rate; and T = Tesla.)

Anonymous, "Safety of NMR" (editorial), *The Lancet, i,* pp.913-914, April 20, 1985.

Reviews the bioeffects of B, dB/dt and RF fields used in NMRI and summarizes the recommended U.K. guidelines. Hazards of cardiac pacemaker EMI and implants, such as ferromagnetic aneurysm clips and metallic prostheses, are discussed, as are NMRI risks to pregnant women.

Peter J. Bore, "Safety of NMR," *The Lancet, i,* pp.1107-1108, May 11, 1985.

Criticizes the April 20 *Lancet* editorial (see above) as incomplete and for oversimplifying the known and potential hazards of NMRI. Numerous suspected bioeffects, as well as physical hazards, are mentioned. In light of what is unknown, states Bore, "It is disturbing to hear clinicians claim that NMR is completely safe...we must deal more comprehensively with the topic...."

William G. Bradley, Jr., W. Ross Adey and Anton N. Hasso, *Magnetic Resonance Imaging of the Brain, Head and Neck,* Rockville, MD: Aspen Systems, 1985.

Presents the fundamentals of NMRI. Adey's chapter, "Tissue Interactions with Electromagnetic Fields," reviews bioeffects at the cellular and molecular levels due to B, ELF dB/dt, RF and ELF-modulated RF fields, as well as their relevance to NMRI. Adey recommends prudence in screening patients for NMRI and in the duration and frequency of exposure – despite its extensive use without reports of lasting adverse effects – since "mechanisms underlying tissue-field interactions are not fully understood." He also states that NMRI "would appear contraindicated in pregnancy."

Thomas F. Budinger and Paul C. Lauterbur, "Nuclear Magnetic Resonance Technology for Medical Studies," *Science, 226,* pp.288-298, 1984.

A major review article which summarizes NMRI technology: its development, mechanisms of interaction and clinical applications. Discusses safety and concludes that, at present, NMRI is considered safe, except for interactions with implants and medical electronic devices. The authors state, "Clinical studies involving fields beyond 2 T will require an extension of safety studies...."

Joseph Fetter, et al., "The Effects of Nuclear Magnetic Resonance Imagers on External and Implantable Pulse Generators," *PACE, 7,* pp.720-727, 1984.

Explains that the effects of NMRI on pacemaker function vary according to model and lead configurations, as well as with the strength of the B, dB/dt and RF fields. The authors make recommendations for scanning patients with external pacemakers or implantable single or dual chamber devices. They suggest that patients with the more complex, dual chamber devices should not undergo NMRI.

John R. Fowler, et al., "Magnetic Field Hazard," *The New England Journal of Medicine, 314,* p.1517, 1986.

This letter describes an unusual and potentially fatal accident involving a forklift and an NMRI unit. While a technician was installing a 1.5 T unit, operating at 0.5 T, the extension tines of the forklift – each approximately 2 meters long and weighing 50 Kg – were suddenly yanked off the machine into the magnet chamber, propelling the technician across the room, causing him serious injury. The rescue effort was hampered by the pull of the B field on badges, scissors and rescue equipment, and a policeman was requested to leave the scene because of concern over his gun. Later, members of the rescue team discovered a rather benign but bothersome hazard – erasure of their automated bank cards.

D.M. Kean, et al., "The Effects of Magnetic Resonance Imaging on Different Types of Microsurgical Clips," *Journal of Neurology, Neurosurgery and Psychiatry, 48,* pp.286-287, 1985.

Presents test results on the effects of strong B fields in NMRI on microsurgical clips to detect whether the fields induce heating or produce a force sufficient to move or dislodge the clips. Of 47 clips examined, 34 moved in the B field. No measurable temperature rise was induced by RF. The authors conclude that NMRI is contraindicated for patients with ferromagnetic aneurysm clips.

D. McRobbie and M.A. Foster, "Cardiac Response to Pulsed Magnetic Fields with Regard to Safety in NMR Imaging," *Physics in Medicine and Biology, 30,* pp.695-702, 1985.

Examines the effects of various, strong dB/dt fields on the cardiac functions of anesthetized rats. ECG traces were recorded and compared to readings taken in the absence of the fields. Superficial muscular responses, including limb movements and abdominal contractions, were observed. No changes were found for a number of ECG parameters, nor were there other abnormalities, such as extrasystoles and arrhythmias. Small and transitory increases in heart rate were attributed to increased demand upon the heart by the repeated and large muscle contractions experienced by the rats and not to a direct effect of the magnetic field.

D. McRobbie and M.A. Foster, "Pulsed Magnetic Field Exposure During Pregnancy and Implications for NMR Fetal Imaging: A Study with Mice," *Magnetic Resonance Imaging, 3,* pp.231-234, 1985.

Describes an investigation of the possible effects of strong dB/dt field exposures on 23 pregnant mice and on postnatal development of their offspring. Pregnancies, litter sizes and growth rates of the exposed offspring were normal. Long-term effects were not studied.

William Pavlicek, "Safeguards Help Minimize Potential MRI Hazards," *Diagnostic Imaging, 7,* pp. 166-169, 250, 1985.

A staff physicist at the Cleveland Clinic reviews the potential safety hazards to patients and staff due to B and RF fields and suggests safety measures to avoid them. He recommends a limited-access boundary at B = 15 gauss and posted warning signs at B = 5 gauss near NMRI units. RF burns can be prevented with proper design and maintenance of RF coils, removal of metal objects from patients and selection of proper attenuation values by the operator. Also stressed is the importance of patient screening for metallic implants, aneurysm clips and cardiac pacemakers.

Frank G. Shellock and John V. Crues, "Changes in Corneal Temperature Associated with High-Field (1.5 Tesla)

Magnetic Resonance Imaging: Experience in 118 Patients," presented at *4th Annual Meeting of the Society for Magnetic Resonance Imaging,* March 1986, abstracted in *Magnetic Resonance Imaging, 4,* p.95, 1986.

Describes temperature changes in the corneas of 118 patients under high-field (1.5 T) NMRI. The average corneal temperature increased from 32.7 ± 0.7° C to 33.1 ± 0.6° C. The largest change in temperature was 3° C and no temperature exceeded 34.8° C. Although the temperature increases were significant, the authors conclude that "this temperature elevation is far below the threshold for producing thermally-induced damage."

Frank G. Shellock, Daniel J. Schaefer and John V. Crues, "Thermal Responses to Different Levels of Radiofrequency Power Deposition During Clinical Magnetic Resonance Imaging at 1.5 Tesla," *Ibid.,* p.94.

Evaluates the temperature changes induced at three different SARs: 0.06 W/Kg (brain scans), 0.41 W/Kg (knee scans) and 0.70 W/Kg (lumbar spine scans). Although significant increases in body temperatures were found, "temperature elevation was not considered to be of physiological importance." Significant increases in skin temperatures were also found during brain and lumbar spine scans, "but these temperature alterations were also minimal."

Maria Stuchly, Stephane Mohanna and David Lecuyer, "Exposure to Fields from Magnetic Resonance Imaging," presented at the *8th Annual Meeting of the Bioelectromagnetics Society (BEMS),* Gaithersburg, MD: BEMS, June 1986.

A survey of 0.15, 0.5 and 1.9 T NMRI devices by these members of the Canadian Radiation Protection Bureau indicates that, outside the magnet core and coils, the "RF magnetic field and electric field strengths are less than the values corresponding to 0.05 mW/cm² (0.04 A/m, 14 V/m)." The proposed, voluntary exposure guidelines for Canada are: B = 2 T, dB/dt = 3 T/s, and SAR = 2 W/Kg and 1 W/Kg averaged over any 25% of the body mass for exposures less than 15 min. or over 15 min., respectively. For operator exposures, only a B standard was proposed (0.01 T for 8 hr/day) because of lack of data. These guidelines will be officially published in a year.

T.S. Tenforde and T.F. Budinger, "Biological Effects and Physical Safety Aspects of NMR Imaging and *In Vivo* Spectroscopy," Lawrence Berkeley Laboratory Report No. LBL-20053, August 1985. To be published in *NMR in Medicine: Instrumentation and Clinical Applications,* S.R. Thomas (ed.), New York, NY: American Association of Physicists in Medicine, 1986.

In this extensive summary of the mechanisms of interaction, bioeffects, physical hazards and exposure guidelines associated with B, dB/dt and RF fields from NMRI, the authors report that no adverse behavioral or physiological effects have been found in mammals exposed to B fields up to 2 T and that animals exposed briefly to similar fields do not show cardiac effects. They argue, however, for additional studies on the effects of prolonged exposure on the cardiac and central nervous systems and of exposure to high B fields (2 to 10 T) on cellular, tissue and animal systems. For dB/dt, they conclude that induced tissue current densities less than 1 uA/cm² have not caused harmful effects, although findings of behavioral and physiological alterations have been reported. They note that a dB/dt of 1-2 T/s would induce such maximum current densities in critical organs such as the heart and the brain. With respect to RF fields, they find that more research is needed on the mechanisms of non-thermal effects. Though epidemiological studies do not indicate a cancer risk from NMR devices, the authors state that long-term health assessments are "advisable" and may elucidate the carcinogenic risks of EM fields. They warn that patients with metallic implants may face a "serious risk" due to B and dB/dt interactions and that an EMI hazard exists to pacemakers in B fields greater than 1.5 mT and for dB/dt's of greater than approximately 75 mT/s. Regarding exposure guidelines, the authors believe that the U.S. dB/dt limit of 3 T/s "appears reasonable" and that the F.R.G. guideline for a maximum current density of 3 uA/cm² seems to be consistent, although not "extensively justified on the basis of laboratory data." On the other hand, they conclude that the 20 T/s (rms) U.K. guideline appears "excessive." Includes 476 references.

Barry Vinocur, "Don't Ignore Impact of Siting on Quality of MR Images," *Diagnostic Imaging, 7,* pp.205-208, 1985.

Discusses location, shielding, B field strength and design of patient preparation area. Concludes that high field systems have greater siting problems as they require more shielding and general site preparation.

Roger J. Willis and William M. Brooks, "Potential Hazards of NMR Imaging: No Evidence of the Possible Effects of Static and Changing Magnetic Fields on Cardiac Function of the Rat and Guinea Pig," *Magnetic Resonance Imaging, 2,* pp.89-95, 1984.

Reports no detectable alterations in the normal cardiovascular function of anesthetized rats and guinea pigs after exposure to: (1) B = 0.16 T; (2) sine, triangular and square modulated dB/dt fields from 0.1-2 Hz, similar to those used in NMRI; (3) rapidly switching fields, greater than 2 T/s for 25 ms and timed to occur at different stages in the cardiac cycle, simulating a power failure or shutoff of the superconducting magnet; and (4) AC fields of 50 Hz for periods of up to 90 minutes.

H.R. Withers, K.A. Mason and C.A. Davis, "MR Effect on Murine Spermatogenesis," *Radiology, 156,* pp.741-742, 1985.

Sixty-six hours of continuous exposure to a 0.3 T B field from NMRI did not produce any significant cytotoxicity in spermatogenic cells of mice.

Stuart W. Young, "Hazards and Site Planning," in *Nuclear Magnetic Resonance Imaging: Basic Principles,* New York, NY: Raven Press, pp.127-137, 1984.

Focuses on the concerns and problems faced in NMRI site preparation: includes a model floor plan with B field contours and discusses their influence at various distances on the surrounding environment. Briefly reviews known and potential bioeffects of B, dB/dt and RF fields, as well.

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PEMFs and Chick Eggs (continued from p.1)

In one series of experiments, the Juutilainen team exposed chick eggs to 0.1-80 A/m (rms) 100 Hz sinusoidal, square and pulsed waveforms for the first 52 hours of development and found a consistent effect at field strengths above 1.0 A/m for bipolar signals (those that oscillate above and below the zero level). They saw no change after exposure to a unipolar signal. Because the rate of change of the magnetic field, and therefore the induced current, was identical for the unipolar and bipolar pulses, they conclude that "the teratogenic effects of low frequency magnetic fields are not due to the induced electric fields." This result is consistent with the work of Dr. Abe Liboff of Oakland University in Rochester, MI, on DNA synthesis (*Science, 223,* pp.818-820, 1984, and see *MWN,* October 1983).

In a paper to appear soon in *Radiation and Environmental Biophysics,* Juutilainen's research team reports no significant differences among the three types of signals, contrary to the results of Drs. Jose Delgado and Jocelyne Leal (*Journal of Anatomy, 134,* pp.533-551, 1982, and *137,* pp.513-536, 1983; see also correction in *140,* p.721, 1985). Nor did the Finnish team find support for a power intensity window in this series of experiments. Overall, Juutilainen observed a smaller percentage of abnormalities in both exposed and control eggs than did Delgado and Leal.

In his forthcoming paper, Juutilainen reports that temperature measurements showed that the eggs had not been heated during the exposures. Based on the types and locations of the observed malformations, he suggests that "the developing nervous system, especially the anterior part of the neural tube, is an important target of the magnetic field effects."

Speaking at the *International Scientific Conference on Work with Display Units* (video display terminals or VDTs) in Stockholm, Sweden, on May 12, Juutilainen said that two key variables are the temperature of incubation and the eggs' storage time: increasing either raises the abnormality rate.

In a second paper, which has also been accepted for publication in *Radiation and Environmental Biophysics,* Juutilainen and coworker Keijo Saali report additional evidence of a threshold at 1 A/m from studies with sinusoidal magnetic fields between 30 Hz and 100 kHz. Above 30 Hz, the rate of abnormalities among the chick embryos does not increase with greater magnetic fields (10 or 100 A/m). Here again, they hypothesize a "direct interaction between the organism and the magnetic field," instead of a mechanism based on induced currents.

Studies at 1, 10 and 16.7 Hz produced results that "seemed to be different from those obtained at higher frequencies." Significant effects at 0.1 A/m, the weakest applied field, were found at 1 and 16.7 Hz, but not at 10 Hz — supporting the observation of intensity windows observed by Delgado and Leal with chick eggs and by Drs. Ross Adey and Carl Blackman in their brain-calcium studies.

Juutilainen and Saali measured mechanical vibrations in their exposure system and ruled them out as a cause of the observed abnormalities.

Swedish Mice Study: Effects Still Significant

New data from the Karolinska Institute in Stockholm continue to indicate a statistically significant increase in external fetal malformations among mice exposed to sawtooth pulsed magnetic fields. A replication study is already underway.

Preliminary results released in January raised widespread concern, but some experts adopted a wait-and-see attitude because the controls had fewer abnormalities than predicted by historical statistics — 0.7 percent v. 1.4 percent (see *MWN,* March/April 1986).

After increasing the number of control and exposed fetuses by approximately 75 percent, Drs. Bernhard Tribukait, Eva Cekan and Lars-Erik Paulsson reported that the rate of malformations among the control mice (1.35 percent) was about equal to the norm. Nevertheless, the number of fetuses with external malformations was still significantly higher (at the 0.02 level) for the mice exposed to 15 uT sawtooth pulses. There were 7 abnormal fetuses with a total of 10 malformations among the exposed mice, compared to only one malformation among the controls.

The mice exposed to 1 uT sawtooth pulses also had a higher, though less significant, rate of external abnormalities: 4 malformed fetuses, 1 with 2 malformations.

In an interview in her office at the Karolinska Institute, Cekan said that she is still "a little skeptical about the experimental results because the only observed effect concerned malformations." There were no differences in body weights, resorptions and fetal deaths between exposed and control mice. Cekan contrasted the PEMF results with those from her previous teratological studies with ionizing radiation that showed changes in all these indices. "I'm still uncertain whether the effect could be due to chance," she said.

The Karolinska study is continuing, as more mice are being exposed to square wave, Delgado-Leal-type pulses. The preliminary results showed that these signals have no effect at either 1 or 15 uT. Cekan said that the experiment should be completed in the fall.

Meanwhile, due to the intense interest in the Karolinska results — especially with respect to the potential risks to pregnant VDT operators — a replication study is already underway. At the Stockholm VDT conference, Paulsson announced that Dr. Gunnar Walinder at the University of Agriculture in Uppsala, Sweden, has been awarded a grant of 500,000 Swedish Krona (approximately $70,000) to repeat the experiment. There will be one change, however: the Uppsala group will use a CBA strain of mice. The Karolinska group used C3H mice.

Poland: TV PEMFs Affect Rats

PEMFs from black-and-white and from color television sets affected rats in a study at the Institute of Occupational Medicine in Lodz, Poland. At the Stockholm VDT conference, Dr. Henryk Mikolajczyk reported that the offspring of female rats exposed before and during pregnancy to TV radiation suffered "detectable" but ambiguous macroscopic effects. Male rats had lower testicle weights following exposure.

The rats were exposed to broad-band electric fields of 1.35-1.73 V/m and 0.63-0.81 V/m in front of, respectively, the black-and-white and color TV sets. The electrostatic potential was 2-3 kV/m.

At a press conference, Mikolajczyk said that he believes "there is some risk" for pregnant VDT operators.

Mild and Sandstrom in Sweden

At the Stockholm VDT conference, Monica Sandstrom of the University of Umea, Sweden, and Dr. Kjell Hansson Mild of the National Board of Occupational Safety and Health in Umea reported negative results.

They exposed chick embryos for 42-47 hours to 20 kHz triangular (sawtooth) pulses with a rise time of 45 usec and a fall time of 5 usec, with peak-to-peak magnetic fields of 0.1, 1.5 and 16 uT (0.08, 1.25 and 13.3 A/m) and corresponding rates of change of 0.03, 0.3 and 3.3 T/sec. They detected no significant differences in the number or types of abnormalities at any of the three intensities, compared to the controls.

Interestingly, the Umea team's sawtooth pulses match those used in the experiments at the Karolinska Institute, which showed a significant increase in external abnormalities among the mice fetuses (see box on p.10).

Sandstrom and Mild pointed out that the numerous chick-PEMF experiments all differed in at least one of the principal exposure parameters. This fact, coupled with the reports of frequency and intensity windows, led them to interpret their own results with caution and stopped them from drawing any far-reaching conclusions. Nevertheless, they did state that "It is quite likely that other factors than the pulsed magnetic field are of importance for causing an effect on embryonal development."

To highlight the variations among the experimental setups, Sandstrom and Mild showed how the magnitude and direction of the induced current passing through the chick embryos differed in the various studies: Delgado-Leal and Sandstrom-Mild placed their eggs in the coils with a horizontal magnetic field; Juutilainen stood his eggs with the blunt end up in a vertical magnetic field; and a University of Rochester, NY, team placed the long axes of the eggs perpendicular to the magnetic field *(Journal of Anatomy, 139,* pp.613-618, 1984, and *MWN,* June 1984).

Sisken and Pilla in the U.S.

A research team headed by Drs. Betty Sisken and Arthur Pilla has found no significant increase in the numbers or types of abnormalities among chick embryos exposed to PEMFs with complex waveforms.

The eggs were exposed to two different types of bipolar magnetic fields: (A) pulses of 250 usec followed by 6 usec of opposite polarity, repeated at 3.8 kHz for a burst duration of approximately 50 msec, with each burst repeated at 2 Hz, for an average magnetic field of 0.1 gauss (0.1 G = 10 uT = 8.3 A/m) and rates of change of 0.01 G/usec (1 T/sec) main polarity and 0.4 G/usec (40 T/sec) opposite polarity; (B) pulses of 200 usec followed by 20 usec of opposite polarity, repeated at 4.4 kHz for a burst duration of approximately 5 msec and repeated at 15 Hz for an average magnetic field of 0.5 G and rates of change of 0.08 G/usec main polarity and 0.8 G/usec opposite polarity. The second pulse is used by Electrobiology, Inc. (EBI), to treat bone fractures.

When eggs were exposed to pulse B for seven days, there was a doubling in the percentage of abnormal chick embryos, but this increase was not significant. There was a smaller increase in abnormalities when the eggs were exposed to pulse A for seven days.

In a paper to be published in the *Journal of Bioelectricity* later this year, the researchers suggest that, based on an analysis of the electrochemistry of ion binding at the cell surface, "the effective portions of both signals occur during magnetic field collapse" – that is, for the 6 and 20 usec pulse segments of opposite polarity.

Sisken, who is with the Department of Anatomy at the University of Kentucky in Lexington, has previously reported positive results when she amputated one of the embryo's limbs immediately before applying PEMFs. Speaking at the 1983 meeting of the Bioelectromagnetics Society in Boulder, CO, Sisken said that delaying PEMF exposure for 24 hours protected the embryo from abnormalities. Pilla is at the Mt. Sinai School of Medicine in New York City.

(continued on p.15)

ONR PEMF Project Delayed

A problem with the mechanical vibration recorders – as delivered by the manufacturer – has delayed the Office of Naval Research's (ONR) international PEMF project.

"We've fixed it," Paul Wagner of the Environmental Protection Agency's (EPA) Office of Radiation Programs in Las Vegas, NV, told *Microwave News.* Wagner and EPA's Richard Tell designed the exposure systems, which will be used in five labs in the U.S., Canada, Spain and Sweden to study the effects of PEMFs on chick embryos.

The experiments were scheduled to begin this spring but have now been pushed back until the fall. Under the study protocol, the eggs cannot be exposed in the summer or winter in order to limit variations in ambient temperatures.

The ONR project is designed to replicate the original Delgado-Leal chick embryo experiments or, alternatively, to identify the cause, if other than PEMFs, for the eggs' abnormal development (see *MWN,* January/February 1986).

UPDATES

BIOLOGICAL EFFECTS

Interest in UV-A Growing...A new FDA study indicates that UV-A radiation used by many commercial suntanning salons and often claimed to be "safer than the sun" may, in fact, lead to skin cancer and premature skin aging. The study, by Dr. Victoria Hitchins at the FDA's Center for Devices and Radiological Health (CDRH), found that UV-A at levels comparable to those emitted by standard tanning devices produced a three-to-fourfold increase in the mutation rate of exposed mouse cells—indicating potential cancer-causing effects. Although UV-A, with longer wavelengths than UV-B radiation used in older tanning devices, may be less likely to cause severe sunburn and corneal burns, its greater skin-penetrating ability may induce serious long-term damage, warned Dr. C. David Lytle, acting director of the center's biophysics division. Lytle added that repeated UV-A exposure may also cause cumulative and permanent eye damage, including cataracts and retinal lesions, and urged the use of protective goggles, even when eyes are closed, during tanning sessions. These new findings are consistent with those of Drs. Meyrick Peak and Jennifer Peak, of the Argonne National Lab, who showed that UV-A can cause breaks and cross-links in cellular DNA (see *MWN,* January/February 1986). For more information about the CDRH findings, contact: Dr. Victoria Hitchins at (301) 443-7110 for research inquiries and Ms. Diana Woods at (301) 443-4190 for consumer questions....Also, watch for the forthcoming paper, "Artificial Suntanning: Spectral Irradiance and Hazard Evaluation of Ultraviolet Sources" by H.P. Gies, C.R. Roy and G. Elliot in the June issue of *Health Physics*....On Saturday, May 10, 1986, *The New York Times* reported on independent studies of Nepalese villagers and Australian aborigines indicating that excessive exposure to sunlight can cause cataracts, and therefore suggesting that wearing sunglasses with dark lenses could protect the eyes from UV radiation. However, in a letter to the *Times* (May 26), Dr. Robert Sekuler, of the Neurobiology-Physiology and Ophthalmology Department at Northwestern University in Evanston, IL, warns that many dark sunglasses not only do not block UV, but place the wearer at increased risk by allowing the pupils to open wider, exposing the eyes to higher doses of invisible, yet harmful radiation. "Instead of rules of thumb," Sekuler recommends, "consumers should get reliable industry-wide labeling."...See also *Newsweek's* June 9 cover story: "Danger in the Sun: A Good Tan May Be Hazardous to Your Health."

COMMUNICATIONS

All Clear on Vashon Island... Washington state epidemiologists have found no evidence that a satellite communications complex is causing cancer among residents of Vashon Island near Seattle. In a May 14 letter, Dr. Samuel Milham and Steve Norsted informed island residents that there is no excess cancer among people living near the Alascom earth station in Paradise Valley. Residents there had reported a cluster of nine cancer cases, including five among women under forty. The satcom station handles telephone traffic between the mainland U.S. and Alaska (see *MWN,* March/April 1986). A cancer registry at the Fred Hutchinson Cancer Research Center listed the same number of cancer cases before and after the Alascom station became operational in 1983. (Milham and Norsted emphasized that the latency period for solid tumors is ten years.) Jay Becker, the editor of the *Vashon-Maury Island Beachcomber,* told *Microwave News* that he is satisfied that there is no cancer cluster but said he is not sure that all the island residents agree.

COMPATIBILITY & INTERFERENCE

Power Surge Downs Rocket... The loss of a NASA Delta rocket and a $57.5 million weather satellite on May 3 has been blamed on two power surges in the rocket engine's electrical system. The May 12 *Aviation Week* reports that telemetry data show that that there were two 150 amp spikes, one lasting about 6-8 milliseconds, the other about 14-15 milliseconds; these spikes caused the main engine to shut down after the voltage in its battery dropped from 28 to 11 volts. Following the loss of power, the Delta rocket began to tumble and was destroyed by ground controllers. There was immediate speculation that a stray radio signal might have been responsible for the engine malfunction, but this possibility was later discounted. On May 10, the *Washington Post* disclosed that after a 1974 accident the electrical system of the second and third stages of the Delta rocket were modified to protect against short circuits, but that, on the advice of Rockwell International, NASA decided not to modify the first stage — the one that malfunctioned in May....See also the timely paper by Boeing's George Ketterling and the Air Force's Major Raymond Vogel and Shirley Briggs, "EM Transient Protection Requirements for Avionics LRUs" (LRUs are electronic line replacement units), in the April 1986 issue of the *IEEE AES Magazine,* published by the Aerospace and Electronic Systems Society.

Open Door Policy... President Reagan's E-4B emergency command plane, a Boeing 747 electronically equipped to serve as a control center in the event of nuclear war, can be an EMI menace. Residents of San Bernardino, CA, not far from March Air Force Base where the E-4B is parked when the President is at his ranch, have had sporadic difficulties with their remote-control garage door openers over the last several years. "It had us buffaloed for a long time," Dr. Larry Murdock of Genie Garage Doors told the Associated Press (April 4), but then he noticed that the problems always accompanied the President's visits. Although the White House press office refused to confirm or deny the allegations, *The Sun,* a San Bernardino paper, reported on April 8 that the Air Force had acknowledged that the E-4B might be responsible. Murdock, who has a doctorate in physics, told *The Sun* that the garage doors returned to normal when the President went back to Washington, DC.

EMI-RFI Market... Frost & Sullivan, Inc., is forecasting an upward trend through the end of the decade for the EMI test equipment industry, due to both the virtual "omnipresence" of electronic and digital devices and the need to comply with FCC rules. The firm's 239-page report, *Electromagnetic and Radiofrequency Interference Test Equipment* (No.1521), predicts a compound annual industry growth rate of 12%, from sales of more than $180 million

in 1984 to nearly $320 million by 1989. Shielded screen rooms, the number one seller, are expected to account for 50% of the market. The largest annual percentage increases are expected in the computer industry (15%) and in the U.S. government (14%). A copy of the report is available for $1,800 from Frost & Sullivan, Inc., 106 Fulton Street, New York, NY 10038, (212) 233-1080.

GOVERNMENT

Gearing Up for Star Wars... Research on the "Star Wars" missile defense system is intensifying, prompting growing interest in health effects associated with exposure to weapon systems that use high-power, pulsed microwave or millimeter-wave radiation. As Dr. Jim Toler of the Georgia Institute of Technology in Atlanta noted at last year's Bioelectromagnetics Society (BEMS) meeting in San Francisco, CA, there are virtually no data on which to base a safety standard for these types of radiation. Now the Army and the Air Force are coming to the rescue. The Walter Reed Army Institute of Research (WRAIR), with labs in Washington, DC, and Forest Glen, MD, will soon begin experimental studies using two different high-power pulsed sources: two 200 million watt (MW) peak power units operating in the 2.5-3.0 GHz frequency range, produced and tested by the Sandia National Labs, and a 10 MW peak power unit (10 GHz) designed by the Naval Research Labs. The WRAIR also has several large anechoic chambers and other pulsed and continuous wave generators in the 0.9-35 GHz range. The WRAIR's interdisciplinary research team is headed by Lt. Col. Edward Elson, MD. In the months ahead, the Walter Reed group will explore the possibility of collaborating with other researchers who wish to make use of the lab's unique equipment. Meanwhile, the Air Force School of Aerospace Medicine (AFSAM) at Brooks Air Force Base, TX, has put the word out that it is looking for a contractor to do research on the "behavioral effects of ultrashort, high peak power pulsed microwave radiation." According to a notice published in the May 21 *Commerce Business Daily* by the AFSAM, those who wish to do this work must have security clearances. In fact, they will need a clearance just to apply. One AFSAM staffer told *Microwave News* that the biological studies themselves will not be classified, but that the principal investigator will need clearance to attend classified briefings. For more information, contact AFSAM's James Merritt at (512) 536-3583. The AFSAM has already sponsored a number of research contracts: Toler and his associates at Georgia Tech prepared a report on "The Effects of High Peak Power Pulsed Millimeter Waves," which includes a literature review – the basis for Toler's 1985 BEMS paper – and they have also designed a millimeter-wave (35 GHz) exposure system for future biological studies. Toler's report to the Air Force is in press and should be ready for distribution at the end of the summer. In addition, the Air Force sponsored research at the University of Utah, which yielded a paper, "Absorption of Millimeter Waves by Human Beings and Its Biological Implications," by Drs. Om Gandhi and Abbas Riazi. Writing in the February 1986 *IEEE Transactions on Microwave Theory and Techniques,* Gandhi and Riazi conclude that there are "potential problems" associated with irradiation in the millimeter-wave frequency band, including "extremely high superficial SARs even for incident power densities of 5-10 mW/cm^2 recommended in safety guidelines. They also urge continued study of occular effects due to energy deposited in the cornea and of the differences in thresholds for perception between millimeter waves and infrared radiation. How exactly might microwaves be used in the Star Wars program? *Microwave Systems News and Communications Technology* gives some hints in a special report, "SDI Offers Challenges and Advances in Technology," in its March 1986 issue. It is doubtful that anyone sees high-power microwaves as a "hard-kill" directed energy weapon, more likely are their potential as a "soft-kill" or "hard-jam" weapon, according to the authors of the report: These systems either burn out the electronics of missiles, aircraft and radars or irreversibly upset their operation.

Radio Marti Compensation... The FCC has approved five new compensation claims to Florida AM radio stations for expenses incurred in offsetting Cuban interference. On January 22, Miami's WNWS was awarded $113,271 and, on February 5, WIOD, also of Miami, was granted $84,027. Then, on February 25, the FCC awarded WVCG of Coral Gables $245,751 for anticipated expenses for increasing nighttime power. More recently, on April 4, WEAT of West Palm Beach was granted $14,397 and, on April 11, WINZ in Miami was awarded $31,460. The first and only previous FCC award ($12,265) was made to WSUN of St. Petersburg in March 1985 (see *MWN,* April 1985). All of the awards to date are for costs incurred *before* Radio Marti went on the air at 1180 kHz on the AM band. Interestingly, despite all the fears, Cuba has not jammed Radio Marti; in fact it has hardly retaliated at all. Compensation is authorized under the law that set up Radio Marti. In 1984, the FCC scrapped the original $250,000 ceiling on claims and ruled that the cost of protective equipment was also reimbursable. Despite the FCC's approval of the six awards, none of the stations has actually received any money, at least partly because the United States Information Agency (USIA), Radio Marti's parent agency, has yet to ask Congress for the funds.

MEASUREMENT

Infrared Radiation (IR)... Barnes Engineering Co. has published the *Handbook of Infrared Radiation Measurement* to help others find solutions to industrial problems involving the measurements of temperature and heat flow. The well-illustrated, typescript, 82-page volume covers the fundamentals of IR and the instruments necessary to measure it. The handbook is available for $6.95 from Barnes Engineering Co., 44 Commerce Rd., PO Box 53, Stamford, CT 06904, (203) 348-5381.

MEETINGS

Wroclaw EMC... Researchers from Bulgaria, England, Japan and the U.S.S.R. will participate in a session on "EM Emissions Related to Earthquakes" at the *8th International Wroclaw Symposium on EMC,* which will be held June 24-26 in Poland. In other sessions, papers will address EMC standards in Czechoslovakia, mechanisms of millimeter

wave bioeffects, EMI problems related to TV transmitters, suggested human exposure guidelines in Italy and RFI in shipboard power lines. For more information, contact: EMC Symposium, Box 2141, 51-645 Wroclaw 12, Poland.

Biomedicine and EM Fields... Last December, the Institution of Electrical Engineers (IEE) in London, England, held an *International Conference on Electric and Magnetic Fields in Medicine and Biology*. Thirty-three papers from the meeting have now been published, covering childhood cancer and power lines, electrical stimulation and bone healing, a magnetic nerve stimulator, effects associated with a 750 kV power line and many other topics. A copy of the paperback volume is available in the U.S. for $56.00 from PPL Dept., IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854, (201) 981-0060, ext.382. Credit card orders are accepted. If you do not prepay, add $2.25 for postage and handling. *Non-U.S. residents should contact the IEE, Savoy Place,* London WC2R 0BL, U.K., (01) 240-1871, ext.222.

DOE-EPRI Contractors Meeting... The 1986 review of research by contractors to the Department of Energy (DOE) and to the Electric Power Research Institute (EPRI) will be held at the Sheraton Denver Tech Center in Colorado, November 17-20. The number of presentations will be smaller this year because the New York State Power Line Project has come to an end. A block of rooms has been reserved at the special rate of $50/night, plus tax; call (303) 779-1100 for reservations. For more information, contact Dr. William Wisecup, W/L Associates, 600 S. Frederick Ave., *Gaithersburg, MD 20877, (301) 948-0642.*

POWER LINES

Texas Developments...A consortium of utilities has decided to abandon the proposed 153-mile Walker-Matagorda, TX, DC power line and has petitioned the Federal Energy Regulatory Commission (FERC) for permission to do so. The utilities plan to use existing AC lines in lieu of the planned ±400 kV line. Central Power & Light Co., Houston Lighting & Power Co. and Southwestern Electric Power Co. gave up on the project on May 1, almost two years after a state Public Utilities Commission (PUC) administrative law judge recommended against construction of the line because of potential public health risks. The PUC then remanded the case for further hearings (see *MWN,* November 1984), but the utilities filed suit in District Court in Austin challenging the PUC's jurisdiction in questions of public health. The utilities were initially victorious but then suffered a reversal that would have required a new trial. As a result, they decided to make do with their AC lines....Meanwhile, Houston Lighting & Power Co. is preparing its appeal of the $25 million decision it lost last November (see *MWN,* November/December 1985). The judgment, which cited the utility for "reckless disregard" of *children's health in siting a 345 kV power line across school* property, was based primarily on potential health risks.

Funds for Bioeffects Research... When should government officials stop paying for studies on a particular risk? Professor Granger Morgan of Carnegie Mellon University in Pittsburgh, PA, poses this question with respect to 60 Hz health effects in an editorial in *Science* magazine (May 23). Citing the $25 million award for punitive damages against Houston Lighting and Power Co. over the siting of a power line and the trend toward slashing ELF research budgets (see *MWN, November/December 1985 and above*), Morgan writes, "We have invested enough to produce a body of science that, in its current state, will support vigorous adversarial debate and rancor for years to come and are now truncating government research funding before producing enough science to resolve the question of risk." In a telephone interview, Morgan explained that much more work must be done on ELF bioeffects since we are still formulating the questions to be answered – a far cry from devising the appropriate stopping rules. Morgan's editorial was much discussed at the June Bioelectromagnetics Society meeting in Madison, WI. Indeed, at the opening session, Dr. Ross Adey of the VA Hospital in Loma Linda, CA, called it "irresponsible." Criticisms centered on the fact that Morgan did not distinguish between risk-related studies and pure or fundamental research on the biological action of electromagnetic fields. And while the amounts already spent on ELF research studies might appear to be large they are minuscule when contrasted with the size of the utilities that build and operate the power lines. (Note that there is a typographical error in the fifth line of the first paragraph of Morgan's editorial: the word "effect" should be replaced with "effort.")

Interference... Three recent papers from the IEEE Power Engineering Society: (1) "Carrier Frequency Interference from HVDC Systems" by Neal Patterson of Montreal Engineering Co. in Canada, in the November 1985 *IEEE Transactions on Power Apparatus and Systems;* (2) "Effect of Power Lines on AM Radio Broadcast Radiation Patterns" by R.C. Madge and D.E. Jones of Ontario Hydro in Toronto, Canada; and (3) "Electromagnetic Interference Measurements at 900 MHz on 230 kV and 500 kV Transmission Lines" by the BPA's V.L. Chartier in Vancouver, WA, R. Sheridan and J.N. DiPlacido, of Chas. T. Main, Inc. in Boston, MA, and M.O. Loftness, a consultant in Olympia, WA. The latter two papers appeared in the April 1986 *IEEE Transactions on Power Systems.*

STANDARDS

Computer EMI in Canada... The Canadian Department of Communications has proposed amending its EMI rules for digital equipment. The March 8 proposal would make the Canadian regulations essentially the same as those adopted by the FCC in the U.S. – the limits for conducted and radiated emissions, for both Class A and B devices, are identical. Copies of the Canadian standard are available from the Standards Code and Information Center, NBS, Admin. Bldg. A629, Gaithersburg, MD 20899, (301) 921-2092. Ask for No. TBT 86.45. Or write directly to S.N. Ahmed, Engineering Programs, Dept. of Communications, 300 Slater St., Ottawa, Ontario K1A 0C8, Canada.

Satcom Antennas... The Electronics Industries Association (EIA) has issued a proposed revision of its 1973 recommended standard, EIA-411, *Electrical and Mechanical Characteristics of Earth Station Antennas for Satellite Earth*

Communications. The detailed proposal has a chapter on on-site antenna measurements, including specifics on protection against radiation hazards. For more information, contact Standards Sales Dept., EIA, 2001 Eye St., NW, Washington, DC 20036, (202) 457-4900. Refer to proposal No.1661.

IEC on Short-Circuit Currents... The International Electrotechnical Commission's (IEC) Technical Committee No.73 has issued a new standard for the calculation of the effects of short-circuit currents for AC systems with rated voltages up to 72.5 kV. The 49-page standard covers the electromagnetic effect on rigid and slack conductors as well as the thermal effect on bare conductors. A copy of IEC Publication No.865 (1986) will soon be available for $47.00, plus $5.00 postage and handling, from the International Sales Dept., American National Standards Institute, 1430 Broadway, New York, NY 10018.

VDTs

NIOSH Pregnancy Study...NIOSH has moved a step closer to starting its planned epidemiological study of reproductive risks among VDT operators. The federal Office of Management and Budget (OMB), which rejected NIOSH's study protocol last December, conditionally approved virtually the same study plan on appeal in June. The decision came just weeks after witnesses at two separate congressional hearings suggested that the OMB was blocking the study because of pressure from Bell South, one of the companies that agreed to participate in the project but objected to the protocol (see *MWN,* January/February 1986).

Resources...A Swedish research team has found a possible association between VDT use and operators' skin problems. The 13-member team from the National Board of Occupational Safety and Health (NBOSH), in conjunction with the Karolinska Institute and the Huddinge Hospital, found that "there may be a relation between VDT work and an aggravation of seborrheic dermatitis, acne and rosacea, and possibly also the provocation of poikiloderma of Civatte." The results are included in a five-part study published in the *Scandinavian Journal of Work and Environmental Health, 11,* pp.457-493, 1985: "Subjective Symptoms and Discomfort" (Part I), "Physical Exposure Factors" (Part II), "Ophthalmologic Factors" (Part III), "Refraction, Accommodation, Convergence and Binocular Vision" (Part IV) and "Dermatologic Factors" (Part V). The authors caution that the skin problems may have resulted from either physical or psychological factors and note that none of the observed skin disorders resembled VDT-related rashes reported in Finland in 1982. The study also found that VDT operators reported vision-related problems more often than other office workers, although ophthalmologic and optometric tests failed to identify the causes of the high rate of complaints....Australian researcher Dr. Michael Repacholi dismisses radiation emissions as potential health risks for VDT operators. In "Video Display Terminals — Should Operators be Concerned?" Repacholi states that, "The answer to the question on VDTs posed by the title of this paper...is a categorical NO in relation to radiation exposure" (emphasis in original). The paper appeared in *Australasian Physical & Engineering Sciences in Medicine, 8,* pp.51-61, 1985. Following a review of selected published radiation research, Repacholi questions whether the Delgado effect — fetal damage due to low-level magnetic fields — can be confirmed. "There is no current theory that predicts [that] developmental or other effects could occur from exposure to magnetic field strengths so much lower than the Earth's magnetic field," he writes. "If the effects were found to occur at these low fields, all electronic devices used in the home or workplace would be called into question." Repacholi is chief scientist at the Royal Adelaide Hospital....In a second review article, Dr. Kenneth Foster of the University of Pennsylvania in Philadelphia concludes that ambiguous and incomplete data have fueled concern about possible reproductive risks for VDT operators. Writing in the March-April issue of the *American Scientist* on "The VDT Debate," Foster states that the available evidence does not establish an association between VDT use and reproductive problems or even the likelihood that such a connection might exist. He criticizes the research to date on reproductive clusters among VDT workers and challenges the view that VDT radiation emissions might be capable of causing damage.

ETC...

Debating the Debate... Dr. Ross Adey's extended review of Dr. Robert Becker's *The Body Electric* and Dr. Nicholas Steneck's *The Microwave Debate,* (see *MWN,* June 1985) — much discussed in the non-ionizing radiation community — has now been answered by both authors. Adey's piece appeared in the January/February 1986 issue of *The Sciences*, the magazine of The New York Academy of Sciences. Becker's response is in the magazine's May/June issue, and Steneck's is in the July/August issue.

PEMFs and Chick Eggs

(continued from p.11)

Rooze and Hinsenkamp in Belgium

Drs. M. Rooze and M. Hinsenkamp have found that the 5 msec, 15 Hz EBI pulses can increase the lengths of the bones in chick embryos. Their studies indicate that PEMF stimulation initiates, as well as accelerates, bone formation earlier than in controls.

Writing in *Reconstruction Surgery and Traumatology (19,* pp.87-92, 1985), they also report that PEMF stimulation increases embryonic weights, with more pronounced gains the longer the exposure. Rooze and Hinsenkamp are at the Erasmus University Hospital in Brussels, Belgium.

In an earlier study with quail eggs, also using an EBI signal (though they do not specify which one), the researchers found evidence that it is the electric field, not the magnetic field, that is biologically active. (See their paper in *Interactions Between Electromagnetic Fields and Cells,* A. Chiabrera, et al., eds., New York, NY: Plenum, 1985.)

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Of related interest, see Dr. W.C. Parkinson's paper, "Comments on the Use of Electromagnetic Fields in Biological Studies," *Calcified Tissue International, 37,* pp.198-207, 1985. ●

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HAWAIIAN HOT SPOTS

Cancer Rates Higher Near Honolulu Broadcast Towers

The cancer incidence in eight out of nine census tracts with broadcast towers in Honolulu, HI, is "significantly higher" than in nearby tracts without sources of radiofrequency (RF) radiation, according to a study by the Hawaii Department of Health.

Dr. Bruce Anderson and Alden Henderson, the authors of the report prepared for the Honolulu City Council, conclude that their study design "does not allow for drawing a cause-and-effect relationship between cancer incidence and RF radiation." They recommend additional research and the adoption of an "interim" standard for public exposures to RF radiation "until more information is available on possible long-term effects."

In a telephone interview, Henderson told *Microwave News* that the study points to a "potential problem" but that there is little chance of a follow-up: "The RF problem has low priority – there are only two of us and there are many other pressing environmental issues."

Marilyn Bornhorst, the Honolulu Councilwoman who requested the study, said that, "Our goal is to try to get the towers out of the city." Until recently, broadcast antennas were sited in down-

(continued on p.14)

Lualualei Leukemia Cluster

Between 1979 and 1985, there were nine cases of leukemia – more than four times the expected number (2.1) – among children living within five miles of the U.S. Navy's communications complex at Lualualei, on the island of Oahu in Hawaii, according to the Cancer Research Center of Hawaii (CRCH). Since 1986 no cases have been reported, however.

A full-scale study of the leukemia cluster was never carried out. "We wanted to get funding to take measurements in the homes of the leukemia cases as well as in those of controls," Dr. Loic LeMarchand of CRCH told *Microwave News*, but "unfortunately we did not get the money and then the rates were back to normal."

There were two leukemia cases in 1982 and three in 1983, and one in every other year between 1979 and 1985, except for 1981, when none were reported.

The study would have been difficult to execute, LeMarchand ex-

(continued on p.15)

Major Cancer-ELF Studies Planned in Sweden

Swedish health officials are planning one of the most ambitious epidemiological studies ever undertaken on the possible relationship between power line magnetic fields and cancer. Dr. Anders Ahlbom of the National Institute of Environmental Medicine in Stockholm will direct the case-control study.

The study will include those who lived within 300 meters of a 220 kV or 400 kV power line for at least one year between 1960 and 1983 and who developed any type of childhood cancer, adult brain tumor or leukemia and some of those who developed breast cancer – a total of approximately 1,200 cancer cases, according to preliminary estimates. The study is expected to cost approximately $500,000 and is tentatively scheduled to be completed in 1991.

The epidemiological study is only one of five 50 Hz projects that are now regarded as high priorities by the Swedish Minister of Energy. (The Swedish electrical distribution system operates at 50 Hz, compared to 60 Hz in North America). The total cost of the five projects will be about $1 million.

The other projects will include: an investigation of cancer promotion in cell cultures; a lifetime exposure study (with cancer as the end point) of experimental animals exposed to 50 Hz magnetic fields; an occupational cancer registry study of electrical workers; and an effort to estimate the electric and magnetic field exposures in a number of different occupations. The tissue culture study will be headed by Dr. Kjell Hansson Mild; the other three will be run by Professor Bengt Knave. Mild and Knave are both with the Swedish National Board of Occupational Safety and Health (NBOSH). Mild is based in Umea, and Knave is in Solna (near Stockholm).

In a telephone interview from Stockholm, Ahlbom said that given current gaps in knowledge, it is important to carry out both well-designed epidemiological studies and basic science research on mechanisms.

Mild will also be responsible for the assessment of exposures in Ahlbom's epidemiological study. The magnetic fields inside homes will be measured, as well as estimated, based on the distance from, and the loadings of, the power lines. Dr. David Savitz of the University of North Carolina in Chapel Hill, and Dr. John Bonnell, who recently retired from the Central Electricity Generating Board in London, U.K., will serve as consultants to Ahlbom's research team, as will Knave.

Ahlbom and coworkers are planning to test the study protocol at one 220 kV power line near Stockholm and then at all the major lines in Stockholm county. Once the feasibility phase is completed, they will take on all the major lines in the country.

On his return from Sweden, where he attended a planning meeting in early May, Savitz told *Microwave News* that he was "very impressed" with what he learned. He said that the Swedish researchers should be able to get a good handle on dosimetry because they have a historical record of the loadings on the lines.

Leukemia Among Finnish Electrical Workers

The incidence of leukemia among Finnish electrical linemen and cable joiners was more than three times the expected rate, according to the preliminary results of an epidemiological study by Jukka Juutilainen of the University of Kuopio, E. Pukkala of the Finnish Cancer Registry and E. Läärä of the University of Oulu.

In an abstract scheduled for presentation at the *2nd Hungarian Symposium on Magnetotherapy*, held in May (see *MWN*, March/April 1987), Juutilainen reported that the cancer incidence was highest among linemen and cable joiners, relative to all types of electrical employees, and that these workers "probably had the strongest electromagnetic exposure[s]." He warned against drawing any conclusions, given the small number of cases.

The three researchers will report results on other types of cancer at a later date. Their data were collected by the Finnish Cancer Registry and Central Statistical Office of Finland.

Juutilainen, who also has been studying the effects of pulsed magnetic fields on chick embryos (see *MWN*, May/June 1986), was unable to attend the Hungarian symposium.

Canadian EMF Committee Gets to Work

The newly-organized Canadian Working Group on Electric and Magnetic Fields (EMFs) is in the process of identifying key research areas and gaps in knowledge related to recent reports linking EMFs to health problems, especially cancer.

At its first meeting, held in Ottawa on March 23, the working group adopted the following statement of goals:

> The purpose of the group is to assess the existence and scope of health effects of electric and magnetic fields related to the generation and use of electricity in order to identify knowledge gaps, to foster research to fill these gaps and to educate the Canadian public on the state of scientific understanding.

Also, staffers from the Canadian Electrical Association,

Health and Welfare Canada, Hydro Quebec and Ontario Hydro briefed the group about their ongoing EMF projects. Chairwoman Dr. Maria Stuchly asked members to assemble a list of possible funding sources.

The EMF group was set up last year, after union officials became concerned about the health risks associated with exposure to EMFs (see *MWN*, November/December 1986). Its next meeting is scheduled for July 6 in Toronto.

Members of the working group are: Jim Bolan, Canadian Union of Public Employees; Gary Cwitco, Communication Workers of Canada; Raymond Del Bianco, Canadian Electrical Association; Dr. Yang Mao, Health and Welfare Canada; Dr. A.M. Muc, Ontario Ministry of Labour; Dr. Robert Phillips, Hospital for Sick Children; Dr. Michel Plante, Hydro Quebec; Dr. Sol Sax, Ontario Hydro; Dr. Maria Stuchly (Chairwoman), Health and Welfare Canada; and Dr. Gilles Thériault, McGill University.

For more information, contact: Dr. Maria Stuchly, Bureau of Radiation and Medical Devices, Room 233, Health and Welfare Canada, Environmental Health Center, Tunney's Pasture, Ottawa, Ontario K1A 0L2, Canada, (613) 954-0306.

Assorted Notes

• On April 29, the Texas Public Utilities Commission granted Houston Lighting & Power Co.'s (HL&P) request to reroute its 345 kV power line. In late 1985, a jury awarded a school district $25 million in punitive damages for HL&P's having put the line on school property without proper permission (see *MWN*, November/December 1985), and last year the Texas Supreme Court refused to grant the utility permission to use the line pending its appeal (see *MWN*, November/December 1986). According to court papers HL&P filed in May, the rerouting around the school is costing $4.26 million and will be completed by August or early September.

• At its May 11 meeting in Tampa, the chairman of the Florida Electric and Magnetic Fields Advisory Committee, Dr. Jack Parker, raised a question about how to deal with power intensity windows: Do you ignore them because of the absence of a clear dose-response relationship or do you set a rule to cover the lowest window? The committee plans to asks its consultants about this problem (see *MWN*, March/April 1987).

• In our last issue, we cited skeptical comments on *Science News*'s coverage of the power line-cancer risk. In its April 25 edition, the science weekly published two responses to the letters. After noting his initial skepticism about a cancer link, USC's Dr. Joseph Bowman went on to write, "The epidemiologists have given the physicist's paradigm a resounding kick in the butt, so now is the time for biophysical scientists to get to work. ...Whatever the eventual outcome of the issue, the physicist's arrogance is no longer justified, and must be replaced with some humble research." Dr. Ross Adey cited the ability of some marine vertebrates to detect electric fields as weak as nanovolts/meter and concluded that, "It is truly the miracle of living matter that extremely weak environmental and intrinsic electromagnetic fields exercise powerful influences on intracellular enzyme systems that govern signaling within cells, cellular metabolism and cell growth."

• The IEEE Power Engineering Society is set to meet in San Francisco, July 12-17. Not a single paper will address bioeffects of AC power line fields. There will, however, be one session on "The Effect of Color on the Acceptance of Transmission Lines," chaired by G.A. Davidson of Stone & Webster Engineering Corp.

Ambient Power Distribution Line Fields Measured

The 60 Hz electric and magnetic fields from 2-14.4 kV power distribution lines in the streets of Montreal, Canada, are "relatively strong," according to a survey by Dr. Paul Héroux of the Institut de Recherche d'Hydro-Québec. Typical values are 32 V/m and 0.16 μT (1.6 mG), respectively, for the electric and magnetic fields.

By comparison, Héroux notes that his data indicate that "a person walking the streets would be above the threshold determined by Liboff et al. between [20% and 77%] of the time" – referring to a study by Dr. Abraham Liboff, which showed that 15 Hz-4 kHz sinusoidal magnetic fields could enhance DNA synthesis in human fibroblasts (see *MWN*, October 1983, and *Science, 223*, pp.818-820, 1984). Héroux cautions that ambient – in contrast to *in vitro* – exposures "vary considerably."

Héroux observes that the magnetic fields vary much less than the electric fields. Also, measured at a height of 1 m, the magnetic fields from underground cables can exceed those from overhead lines – 0.5-1.9 μT vs. 0.15-1 μT.

Based on measurements over 223 km of roads, the magnetic fields were greater than 0.04 μT 90% of the time, greater than 0.16 μT 50% of the time, greater than 0.51 μT 10% of the time and greater than 1.08 μT 1% of the time. See Héroux's paper in *Bioelectromagnetics, 8*, pp.135-148, 1987.

HIGHLIGHTS

Diapulse Back on Market

Fifteen years after the Food and Drug Administration (FDA) ordered Diapulse® – a medical device using pulsed high frequency electromagnetic fields – off the market, the agency has agreed to its use for the treatment of post-operative swelling and pain.

At the end of March, a New York federal court approved a joint FDA-Diapulse Corporation of America proposal to allow the company to market its device for "adjunctive use in the palliative treatment of post-operative edema and pain in superficial soft tissue."

The Diapulse unit uses pulsed 27.12 MHz radiation with 80-600 pulses per second, each having a width of 65 usec. Its peak power is 293-975 watts, with an average power of 1.5-38 watts.

Diapulse was developed by Dr. A.J. Ginsberg in the 1940s and was first marketed in the early 1960s. Following years of acrimonious disputes, the FDA forced it off the market in 1972.

"We got caught in the thermal vs. non-thermal effects controversy," Diapulse Corp. Vice-President Bern Siler told *Microwave News,* "because the device causes no significant temperature rise."

The FDA's Roger Schneider agrees that was part of the problem. "Back in the early days, the agency's compliance staff and its medical advisors were simply not prepared to believe that electromagnetic energy could bring about non-thermal, beneficial effects," he said in a telephone interview. Schneider, the associate director for science at the FDA's Center for Devices and Radiological Health in Rockville, MD, added that Diapulse officials did not appreciate the kinds of medical data needed to satisfy the FDA. "They should have had better-designed experiments to argue their case because in those days anybody who claimed non-thermal effects was thought to be a quack."

Under the settlement, Diapulse Corp. can only market its unit for a small fraction of its original treatment claims. Because the unit was first sold before the 1976 medical device amendments, which codified the FDA's rigorous premarket approval (PMA) process, the company did not have to pass PMA review for any of its original claims – including the now-approved treatment of post-surgery swelling and pain.

The FDA's recent decision was based, in part, on an oral surgeon's "quite dramatic results," in which Diapulse therapy reduced edema and pain, Schneider said. These data were collected some time ago but only convinced the FDA after they were recently supplemented and reanalyzed.

Diapulse Corp. plans to ask the FDA's permission to expand the device's applications, according to Siler. Among its possible future uses are for healing soft tissue wounds and spinal cord injuries (see box).

The Diapulse unit costs $10,500; it can also be leased. Siler said that the company had survived for the last 15 years through sales in European countries, including Austria, England, France and Switzerland. The company is based in Great Neck, NY.

Treating Spinal Cord Injuries with Diapulse

Dr. Wise Young of the New York University (NYU) Medical Center in New York City has successfully used Diapulse radiation to treat cats with acute spinal cord injuries. In functional studies, up to half the cats that received Diapulse therapy shortly after injury recovered within two months, while none of the controls significantly improved.

"The phenomenon is real," Young told *Microwave News* in a telephone interview. "The major problem now is how it works."

Young has found one important clue: Diapulse therapy reduces the amount of calcium accumulating at the site of injury. He speculated that because blood clotting is a calcium-dependent process, Diapulse could affect the clotting mechanism.

The FDA's Roger Schneider, who coordinated the FDA's recent review of Diapulse, called the Young results "impressive."

Young, the director of the NYU Medical Center's Neurosurgery Laboratories, said that he is in the process of preparing papers for publication on his research with cats. He is presently working with tissue culture, he explained, in an effort to try to understand the mechanism of interaction.

Faulty VDT Screens

Certain types of commonly used anti-static VDT screens stop working after six months, according to a Swedish survey of over 100 carbon-treated nylon mesh electrostatic shields. Dr. Mats Berg of the Karolinska Hospital and Ingvar Langlet of the National Institute of Radiation Protection reported this "remarkable" finding in a letter to *The Lancet* (April 4, 1987), England's leading medical journal.

"After some months the carbon film seems to be transformed into a non-conducting state," they concluded. Screens with metal nets or metallized plastic do not deteriorate.

In a telephone interview from his office in Stockholm, Langlet, a physicist, said that the only way one can be certain a shield is still effective is by measuring the static charge: "You cannot say anything about the quality of a screen without testing it in the workplace." When asked whether his results might apply in the U.S.,

Langlet replied, "It could be the same situation as in Sweden."

Berg and Langlet tested the screens as part of an investigation of VDT-related skin rashes. In a letter to *Microwave News*, Berg, who is in the Department of Dermatology, wrote that they are in the midst of a study of 4,000 office workers – 2,000 VDT operators and 2,000 controls. The results should be published in about a year.

Langlet said that the vast majority of the screens tested were the "Power Screens" made by Power System AB, based in Stockholm. Screen Data Corp. of Whippany, NJ, one of the leading sellers of anti-static, carbon-impregnated nylon mesh screens in the U.S., is a subsidiary of Power System, and its screens are the same, according to Screen Data's Mike Kling.

Screen Data and Sun-Flex Inc. of Novato, CA, the other leading U.S. manufacturer of carbon-nylon mesh screens, now use essentially the same carbon-embedded mesh for their monochrome VDT filters. Tony Gault, president of Sun-Flex, said that the fiber is made in the U.S. and is woven into mesh in Switzerland.

Representatives from Screen Data and Sun-Flex challenged the Swedish findings. "We have not had any complaints about our screens; they should last indefinitely," Ed Thomson, Sun-Flex's manager of communications, said.

Langlet recommended that VDTs be retrofitted to guarantee anti-static protection. He said that, in Sweden, the cost of retrofitting a VDT is about the same as two anti-static filters – $150.00.

The reason for the deterioration of the screens is unclear. Langlet suggested that it may have something to do with the action of electrical forces, possibly from air pollutants in the office environment. But he did say that the loss of the anti-static properties is not simply due to age: "We found some unused, old screens and, when tested, they still worked." Another, different problem, he added, is that some of the screens are not properly grounded.

Herman Kappel, president of Kantek Inc. in New York City, another maker of carbon mesh screens, offered a simple test to identify whether an anti-static screen is still working: "If dust is accumulating on the screen, you know something is wrong." Indeed, *The Lancet* letter noted, "Female operators often report that eye make-up is deposited on the VDT screen at the end of the working day."

VDT screens are a $70-million-a-year market in the U.S., industry sources estimate – though there are no reliable statistics available. While some screens exclusively protect against glare, others add an anti-static component and still others also claim to shield very low frequency radiation.

FM Station Accepts 10 μW Limit

A Denver, Colorado FM station, KYGO, has agreed to a set of stringent precautions to limit radiation levels at a camp on whose land its radio tower is located, according to the camp's lawyers.

Attorneys Bruce DeBoskey and Joe Silver, who negotiated the settlement for Beryl and Maelma Main, owners of the Lighted Lantern Square Dance Camp, said that under an agreement signed on June 12, KYGO has reduced power from 100 kW to 1 kW and will operate from an alternate antenna during the camp's summer season. If the radio station opts to use the tower in the fall, it will continue to broadcast at only 1 kW and will erect a fence around all areas of camp property where fields exceed 10 $\mu W/cm^2$.

A recent Environmental Protection Agency (EPA) and Federal Communications Commission (FCC) survey of the radiation levels near the KYGO tower revealed that, "Many people could... visit areas where power densities exceed 1,000 $\mu W/cm^2$." The main camp building is within 100 feet of the tower, and the EPA-FCC team found radiation levels of approximately 100 $\mu W/cm^2$ in the commissary and up to 300 $\mu W/cm^2$ on the patio/deck (see *MWN*, March/ April 1987).

After the EPA-FCC measurements were released earlier this year, Wayne Phillips, KYGO's general manager, told the *Denver Post* that the station plans to relocate. Phillips did not return calls from *Microwave News*. KYGO is owned and operated by Jefferson-Pilot Broadcasting Inc.

Beryl Main has developed non-Hodgkin's lymphoma and intends to pursue a claim that his cancer was caused by the FM antenna. If he does, his suit will be another in a series seeking to link radiofrequency (RF) radiation with cancer (see *MWN*, May/June and September/October 1986).

Last year a California FM station closed down rather than comply with the FCC's RF rules (see *MWN*, March/April 1986).

Difficult Times for EBI

A Food and Drug Administration (FDA) advisory panel has recommended the removal of Electro-Biology Inc.'s (EBI) bone growth stimulator from the market. After reviewing data on patients who had been treated with the device, the Orthopedic and Rehabilitation Devices Panel questioned the efficacy of the EBI stimulator, which uses pulsed electromagnetic fields.

The panel's recommendation, made at a May 7-8 meet-

ing, is not binding; FDA regulators must decide whether to stop the use of the device, which has been on the market since 1979. An FDA spokesman said that the panel members did not find any safety problems with the device; they only questioned its efficacy. The chairman of the panel is Dr. Michael Mayor of the Dartmouth-Hitchcock Medical Center in Hanover, NH.

The FDA spokesman added that only EBI's device is under review at the moment, but that other stimulators will undergo a similar long-term assessment.

In its response, EBI charged that the panel's decision "was based on very limited data," and that the company "will vigorously attempt to rebut the panel's conclusions." Nevertheless, one FDA official told *Microwave News* that the agency is taking the panel's recommendation "very seriously." The FDA could take two to six months to decide the fate of the EBI device.

In some ways, the panel's May decision flows directly out of its discussions at an October 31, 1986 meeting. At that time, panel members voiced the need for double blind studies with concurrent controls to demonstrate the efficacy of electromagnetic bone growth stimulators. As Dr. Randall Lewis, an orthopedic surgeon based in Washington, DC, argued, "I cannot envision any circumstance under which historical control[s] would be adequate." Lewis also stated that "double blind studies are not unethical." Trying to show efficacy without double blind studies has long been controversial (see *MWN*, May 1981).

In other developments, American Medical Electronics Inc. (AME) and Biolectron Inc. petitioned the FDA in March to limit the use of EBI's stimulator for non-union fractures of greater than nine months duration. (AME, Biolectron and EBI are the only three FDA-approved bone growth stimulators.) The two competitors complained that some doctors were using the EBI device for "fresh" fractures and argued that, since the data for the three devices are comparable, they should all be used in the same way – only for fractures nine months or older. EBI said that it will contest the petition, which it regards as "anti-competitive."

And in early June came news that EBI has won a favorable ruling on its long-running patent infringement lawsuit against AME. Official details were not available at press time, but there is speculation that, if the ruling holds, AME may discontinue operations.

Military Systems: A Review

Outlined below is a system-by-system update of recent developments in several major military radar and communications projects.

PAVE PAWS

The maximum time-averaged radiation level in the communities near the Air Force's PAVE PAWS 420-450 MHz radar on Cape Cod was 0.139 $\mu W/cm^2$, according to a survey by the Air Force's Engineering Installation Group (EIG) from Keesler Air Force Base (AFB), MS. The highest reading was taken at a height of 86 feet, atop a fire tower 3.2 miles from – and in direct line-of-sight to – the radar. At all other sites the power densities were significantly less; none exceeded 0.03 $\mu W/cm^2$ at a height of 6 feet.

The survey was prompted in part by a need to monitor exposures of maintenance and construction personnel and in part to assist the Massachusetts Department of Public Health in its investigation of an abnormally high cancer incidence in the Cape Cod area.

On the base, EIG found a maximum field of 3.7 mW/cm^2 atop one of 17 lampposts (38 feet high) and readings of over 1 mW/cm^2 atop 6 others. EIG recommended that the radar be turned off when workers are on these lampposts. At one of 7 security camera locations, each approximately 15 feet high, a level of 745 $\mu W/cm^2$ was measured. At 6 feet above ground level near the lampposts and the security cameras, EIG measured a maximum 1.85 mW/cm^2 field, with many of the measurements below 1 mW/cm^2.

According to *Aviation Week* (May 18), the Air Force had been planning to increase power at the Cape Cod PAVE PAWS radar by 6 dB – a factor of four – but is now holding off. A 6 dB increase at Beale AFB, CA, may occur first, however, if the Air Force receives the necessary funding for fiscal 1989. Meanwhile, the fourth PAVE PAWS radar – at Eldorado Air Force Station, TX – was completed in May.

The EIG's measurements, which have an uncertainty of ±2 dB, are reported in *Radiofrequency Radiation Survey for the AN/FPS-115 PAVE PAWS Radar, Cape Cod AFS, MA: 18-30 September 1986* (Report No.86-33), which was obtained by *Microwave News* under the Freedom of Information Act. For further information, contact: Kevin Gilmartin, USAF Electronic Systems Division, Hanscom AFB, MA 01731, (617) 377-4064.

GWEN DEIS

The Air Force recently issued a draft environmental impact statement (DEIS) for the Ground Wave Emergency Network (GWEN), a 150-175 kHz communications system designed to survive a nuclear electromagnetic pulse (EMP).

In the DEIS, the Air Force concludes that electric fields from the "relay nodes" would be 50 V/m or less – a safety level recommended by John Mitchell of the AF School of Aerospace Medicine at Brooks AFB, TX (see *MWN*, January/February and November/December 1986). Magnetic fields at the fence would be approximately 30 mA/m.

For continuous UHF transmissions, the Air Force estimates that there would be a maximum exposure of

2.9 μW/cm² for a six-foot-tall human 20 feet from the transmitting antenna, inside the public exclusion area – or 1 μW/cm² allowing for the transmitter's 40% duty cycle.

The GWEN DEIS is also available from Hanscom AFB. The Air Force plans to issue a final EIS in August.

OTH-B

The Air Force has released EISs for two planned Over-the-Horizon-Backscatter (OTH-B) radar systems. In an August 1986 DEIS for the proposed central OTH-B radar, to be located in North and South Dakota and/or in Minnesota, the Air Force concludes that power levels in accessible areas would be below the 1982 ANSI limits – 36-1.15 mW/cm² at the OTH-B's operating frequencies of 5-28 MHz.

The Air Force has developed an "Operational Plan for [RF] Interference Avoidance" to limit potential interference to other users of the OTH-B frequencies and its harmonics, including TVs, CB radios, amateur radios and air-to-ground communications, according to the DEIS.

Similar analyses accompany the Air Force's final EIS for the proposed OTH-B radar in south-central Alaska, released in January 1987.

Both EISs are available from Lt. V.G. Brown, ESD/SCO, Hanscom AFB, MA 01731, (617) 271-5364.

The only completed OTH-B, in Maine, is undergoing trials, but delays in computer software development are slowing the process. General Electric, which built the Maine radar, recently received the contract for the Alaska facility.

In other OTH-B news, the Navy has announced plans to seal off a small wilderness island off the coast of Alaska as the initial site for a new, relocatable OTH radar (ROTHR), *Defense Week* reported (November 24, 1986). The Navy hopes to begin operating the ROTHR by 1989. Finally, Australia has announced plans to build a three-station OTH-B radar system; and Japan will send a delegation to the U.S. to study the OTH-B radar, and may build its own.

EMPRESS II

Congressional opposition to the Navy's plan to site its Electromagnetic Pulse Radiation Environment Simulator for Ships (EMPRESS II) on Chesapeake Bay continues to increase (see *MWN*, January/February and March/April 1987). Republican Senator John Warner of Virginia, a former Secretary of the Navy, has introduced an amendment to the Defense Department's fiscal 1988 authorization bill to block *permanently* the Navy's Chesapeake Bay siting recommendation. Democratic Representative Roy Dyson of Maryland, who has in the past led efforts to block siting on a yearly basis, has offered a similar amendment in the House and predicts he has enough votes to pass the measure.

Project ELF

The Navy has suspended further development of the Satellite Laser Communications (SLC) system, which would use blue-green lasers to communicate with submerged submarines, supplementing or replacing Project ELF (see *MWN*, May 1985). The Navy has refused to fund the SLC at $100 million over the next two to three years, a decision which Defense Advanced Research Projects Agency officials complain will kill the project, according to the March 2 *Defense News*.

Meanwhile, Project ELF is "moving toward operational capability," a Defense Department official told *Aviation Week* (March 9): The long-contested transmitter antenna sites in Wisconsin and Michigan are almost completed and submarine receivers are in production.

FROM THE FIELD

Epidemiological Evidence for an EMF-Cancer Link: An Exchange

Excerpted below is an edited and shortened version of An Epidemiologic Perspective on Electromagnetic Fields (EMFs) and Cancer *by Professor Philip Cole, chairman of the Department of Epidemiology at the University of Alabama in Birmingham, which was prepared for the state of Florida's Electric and Magnetic Field Advisory Panel (see* MWN, *March/April 1987). Drs. Nancy Wertheimer and David Savitz's responses to Cole have also been edited and shortened. Savitz revised his comments before making them available to* Microwave News.

Cole's Perspective

Wertheimer and Leeper (1979)...The paper...brought to the fore the question of EMF and cancer among children. The paper represents that all forms of childhood cancer, but especially leukemia, are increased about two- to three-fold among children who are exposed to "high current" configurations in their household wiring....

I was most struck by two aspects of the paper which I do not believe have been mentioned by others and which cause me to be unable to place confidence in it. The first is the complete absence of the analytic methods of epidemiology. Even the primary associations are described only in terms of statistical significance. There are no relative risks (RRs)....

The second problem is what I can only term the paper's "inordinate consistency." There are about 30 (not necessarily independent) comparisons made. When these comparisons are expressed in terms of RRs, they can be seen all (but one) to lie in the range of 2.0 to 3.0....

Finally, the paper represents that the positive results pertain to leukemia, to lymphoma and to nervous system and other cancers of childhood. And...Wertheimer has represented that similar findings pertain to most forms of cancers of adults. In short, it appears that Wertheimer proposes that she has provided evidence that EMF increases considerably the risk of

all forms of cancer, both of children and of adults. This stretches credulity....

With regard to interpretation of the Wertheimer and Leeper 1979 report, there can be little doubt about the possibilities of chance and confounding. Neither of these two factors can explain the results at all. The consistency of the results obviates chance....Thus, we are left with the question, "Is the study biased or does it reflect causality or is there an element of both?" The answer is that it is biased. No other study approaches this one in strength or consistency of findings, despite better methodology....[T]he Savitz study must be regarded as generally superior and, perhaps, much superior. This is especially so for exposure assessment. This, in turn, should cause the Savitz study to be more strongly positive and the more consistent of the two. It is, unarguably, neither.

The Savitz Study (1986)...The [draft] Savitz study must be viewed as the definitive work, to date, on the question of EMF and cancer among children. Its only limitations are those put forward by Dr. Savitz himself: 1) it is somewhat small; 2) cooperation, especially of the controls, was deficient; and 3) results may pertain uniquely to the Denver setting. I consider only criticism number (2) to have...[valid] implications. I also believe that the analysis section is thorough...and the interpretation reasonable, even though it is not an interpretation that I wholly share. The further point that Dr. Savitz has advanced – that exposure measurement needs to be improved, perhaps goes without saying, but it is not clear that it could have been done better.

I consider the Savitz study to be an essentially null study and one that is, in any case, very different in its results from the Wertheimer and Leeper (1979) report. My opinion is based on three observations: 1) The amount of data generated and the number of RRs presented are enormous. Yet, there are nearly as many RRs below 1.0 as above.... 2) There is no consistent dose-response.... 3) A crucial age-effect is missing....

This interpretation is offered of the Savitz study: The results presented show a slight but inconsistent trend to the positive. There is no dose-response relationship and no internal consistency in the data. The study may be viewed as only suggestive of a weak effect. It argues strongly against any major or consistent effect. It is consistent with nullness.

Other Epidemiologic Studies...Most of these studies were done in an occupational setting and used industry or job title as an indicator of EMF exposures. However, four of the studies pertain to residential EMF exposures....This is not an exhaustive review....The proportionate mortality studies [PMRS] provide the most limited and potentially flawed data pertaining to cancer and EMFs, while [retrospective follow-up studies (RFUS)] are the most methodologically sound. The case-control studies [CCS] occupy an intermediate position. The residential studies are discussed separately.

PMRS...The six most pertinent studies [are Milham (1982), Wright (1983), Coleman (1983), McDowall (1983), Calle (1985) and Milham (1985)]....A diversity of occupations involving potential EMF exposures were considered in these studies and all subjects were assumed to have experienced such exposures. However, it is probably true that many of these workers were, in fact, exposed little or not at all....

The PMRS provide little or no evidence that EMF exposures are a cause of human leukemia. They are not convincing mainly because of the inherent limitations of a PMR....In summary, the PMRS are interpreted as, essentially, negative.

CCS...[McDowall (1983), Pearce (1985), Lin (1985), Flodin (1986) and Stern (1986)] have a number of methodologic limitations for the purpose of evaluating the relationship between EMFs and cancer. For example, no direct measurements of EMFs were made in any of them and, with the exception of Lin's study, no attempt was made to evaluate dose-response. Furthermore, the men in these studies may have been exposed to other carcinogens which may explain their apparent excess of these cancers. Nonetheless, there is a clear tendency for positive findings in these studies. This is highly unlikely to be due to chance. It is also difficult to imagine how a bias or confounding by some factor could explain the consistent positive findings. However, a possible explanation of these positive findings is a propensity of investigators to report only positive results....

RFUS...None of the [five Swedish RFUS, Vagerö (1983), Vagerö (1985), Olin (1985), Barregard (1985) and Törnqvist (1986)]...found an excess of leukemia and four of the five found no excess of cancer of the nervous system. The fifth study...[did].

The results of the RFUS clearly contradict the CCS. The RFUS also suffer limitations as do the CCS. For example, two of the studies were quite small and so do not provide persuasively negative results....However, on the whole, the methodology of these RFUS is better than that of the CCS. More importantly, these RFUS were designed specifically for the purpose of investigating the role of the EMFs in the etiology of cancer....For these reasons, considerably more weight should be placed on the results of the RFUS, than on the CCS....The occupational RFUS provide moderate or strong evidence that EMFs have no meaningful role in the etiology of cancer.

Residential Studies of EMFs and Cancer...Fulton (1980) conducted a CCS of childhood leukemia and residential wire configurations in Rhode Island. These investigators did not find a positive association....However, the validity of this study was challenged by Wertheimer. She claimed that the control distribution of residences was biased....The result of this bias would be to provide underestimates of the RRs. She re-analyzed a subset of Fulton's data, presumably correcting for this urban bias, and reported a statistically significant positive association. Fulton did not respond to her criticisms of his study. Thus, the findings and interpretation of Fulton's study are unclear and it must be considered a non-persuasive negative study.

Tomenius (1986) conducted a CCS of childhood cancer and EMFs in Sweden....An overall statistically significant RR of 1.4 was reported for all cancers....However...among the exposed, there is an *inverse* trend between distance of dwelling from the relevant electrical configuration and cancer risk. This observation argues against a causal interpretation of the weak overall positive finding.

Wertheimer and Leeper (1982) conducted a CCS of adult cancer in relation to residential wire configurations. They reported a strong and remarkably consistent positive association between overall cancer and EMFs....However, as in her study of childhood cancer, the coding of residential wire configurations was not done blinded and hence the positive findings may reflect observer bias. This study also suffers other limitations similar to those described above for her study of childhood cancer.

McDowall['s] (1986)...RFUS [showed]...no overall excess of all cancer mortality, nor of leukemia....There was a slight, nonsignificant excess of lung cancer mortality. However, this could not be directly attributed to EMFs. A limitation of this study is that some of these people probably moved away from these residences subsequent to 1971, introducing a dilution of the outcome. Nonetheless, this is a sound epidemiologic study which provides additional evidence that exposure to EMFs is unrelated to the occurrence of human cancer.

New Information...[I]f it were true that EMFs cause leukemia

among children...then one might reasonably expect that during this century the childhood leukemia death rate would have risen more or less progressively....It is evident that power consumption has risen strikingly, there having been nearly a 100% increase in every decade. At the same time, leukemia mortality rates have shown a rise of about 40% per decade up to about 1950 and, typically, a *decline* thereafter....

These results for leukemia and CNS neoplasms, taken together, suggest that either there is no causal relationship between exposure to EMFs and these conditions in children or that, if there is any effect, it must be very small....

Conclusions: The collective pattern of results that emerges from the epidemiologic reports is that of a weak, transitory effect that is not supported by consistent dose-response relationships or other internal characteristics of the data. A summation can only be that either there is no relationship between EMFs and cancer in human beings or if there is an effect it must be of very low magnitude even among people who are moderately to heavily exposed.

The above interpretation is fully supported by the absence of a temporal correlation between per capita electric power consumption and mortality rates of leukemia and CNS cancer among children in the United States.

Wertheimer's Response

...Dr. Cole seems to be reaching too hard to find explanations that deny the generally consistent positive findings of the studies. He says, for instance, that our study cannot be wrong because of chance or confounding, so it must be wrong because of bias; then, not believing that the Savitz results have the same problems with bias, he says they must be wrong because of uncooperative controls....Dr. Cole then recognizes that the major flaws of the occupational studies are unlikely to have produced the positive results found, so he concludes that those positive results are wrong because negative results were not published (though one must realize that powerful funding sources exist that welcome the finding and reporting of negative results), etc.

...I agree with Dr. Cole that it is particularly important to perceive the pattern of a number of epidemiological studies in evaluating a field. However, the strength of effect he looks for may be hard to attain for 60 Hz EMFs, because control groups will be universally exposed to this agent, diluting the risk ratios....

Responding to Dr. Cole's criticisms of our 1979 paper...He criticizes our method of data presentation. While our presentation was simple, I believe it was adequate (especially since Dr. Cole seems to have been able to compute the RRs and ARs he wanted from the data provided)....

Dr. Cole is skeptical about the similarity of risks seen for several different analyses. This is less surprising when one considers that the various analyses he refers to are simply different perspectives on the same basic data....

Finally, Dr. Cole suggests that since the Savitz study was superior to ours, Savitz should have gotten stronger, more consistent findings than we did. Actually, the differences between Savitz's results and ours (which are not so great) may have little to do with how well either study was done. The differences could be real: For instance, our work covered an era when young children usually stayed at home, but in the era Savitz covered children more often spent time at day-care centers, away from the home. Further, divorce, with division of the child's time between different homes, was probably more common in the era Dr. Savitz covers. Both of these factors, by decreasing the time the child spent in the coded home, may well have weakened Dr. Savitz's results.

Concerning the Savitz study: Dr. Cole contends that the Savitz data show as many RRs under as over 1.0, and that therefore the study is null and fails to confirm our findings. However, many of the RRs (such as those relating to electric fields) that are under 1.0 were not intended to test our hypotheses. No one claimed they should be over 1.0....I don't myself think that counting RRs from non-independent tables is a very useful way to evaluate a study, but at least the results do seem to show that, no matter how one cuts the data, high-exposure homes generally have a greater cancer risk than low-exposure homes....

Concerning other studies cited by Dr. Cole: Dr. Cole discusses a number of studies linking cancer with occupational EMF exposures (although he omits an interesting study by Swerdlow (1983), linking eye cancer (mostly melanoma) to electrical occupations....

I would agree that, in general, these studies cannot cast much light on our present problem because 50-60 Hz exposure cannot be assessed very well from occupational titles alone, and because, although "something seems to be going on," it may have to do with fumes and solvents rather than EMF exposure. However, my rough attempt to sort out probable exposures on the basis of job titles did not suggest that fumes and solvents are the whole story, or even the major part of the story.

I am concerned that Dr. Cole seems to put the most weight on what he sees as negative results from five RFUS studies [Vagerö (1983), Vagerö (1985), Olin (1985), Barregard (1985) and Törnqvist (1986)]; yet each of these studies has either little convincing evidence of 50-60 Hz exposure, or little convincing evidence that the cancer rates were unaffected, or both....

In Tomenius's study only the 200+ kV lines were shown to produce excess exposure. For these power lines a significantly increased cancer risk of 2.1 was, in fact, seen....When...[I reworked his data], a positive dose-relationship with distance is seen....

The problems of the McDowall (1986) study are severe, for he provides no evidence whatever that his "exposed" homes actually do receive increased 50 Hz EMF exposure. In fact... there is little reason to expect such exposure....

Concerning Dr. Cole's contention that childhood cancer rates should have increased in this century if power lines were responsible for a fair share of childhood cancer: This is a naive assumption....There is actually little reason to suppose that exposure to 60 Hz EMFs has increased over the century simply because use of electricity has increased: High power use need not produce high EMFs.

As both the Savitz study and Kaune's work in Washington state showed, the EMF exposure at a house is not related to the total power use in that house. Furthermore, as power use has increased, technology has changed in a number of ways that *reduce* field exposure....

Perhaps most important is the clear finding of the Savitz study that buried distribution wires – a recent technology – generally produce less field in nearby homes than the old-fashioned overhead wires. In connection with this advent of buried wire construction, Dr. Cole's table of changes in the cancer rate of children from 1920-1980 actually fits nicely with the changes expected in EMFs produced in homes by power lines: The years when the old overhead wires were carrying more and more current (1920 into the 1960s) show increasing cancer rates, but these rates seem to have decreased since buried wires became common in the new suburbs....

Savitz's Response

...I should first acknowledge that the array of available epidemiologic information is sufficiently incomplete and contradictory that further inspection of existing data is unlikely to resolve the issue. That is, the existing data are unfortunately compatible with an array of views, including Dr. Cole's judgement that "there is no relationship between EMFs and cancer in human beings or if there is an effect it must be of very low magnitude."

Because I agree with much of what Dr. Cole has written, I will only focus on areas about which I would raise questions. In regard to my own data, I would question the legitimacy of declaring it negative based on a preponderance of risk ratios around the null value. One of the hazards of generating as many risk estimates as I did is the problem of making sense of the pattern. Although many individual risk estimates (e.g., for measured fields) suggest no effect, there are reasons to argue that the results from the analysis of wire codes reflect the best estimate available of long-term low-level magnetic field exposures in the home. If the "best" measure showed an effect and weaker measures showed weaker effects, this would be compatible with a causal relationship. The merits of the different exposure measures are open to debate, but the absence of effect for electric field measures and possibly even for magnetic field measures does not negate the potential importance of the wiring data.

The absence of a clear dose-response for the wire coding data is also acknowledged, but if one considers the relationship of average magnetic field to wire code, this could explain the lack of distinction among the lowest three levels (buried, VLCC, OLCC) and an increasing risk for OHCC and for VHCC, as was found. Part of the reason for no dose-response gradient might be the absence of a real gradient in exposure across the five wire code categories. The most substantial differences in risk corresponded to the most substantial differences in measured magnetic fields related to the wire codes.

...Dr. Cole's suggestion that even supposedly "positive studies" are not entirely consistent prompted me to try to synthesize the information from just the childhood cancer studies [Wertheimer & Leeper (1979), Fulton et al. (1980), Tomenius (1986), Coleman et al. (1985), Myers et al. (1985) and Savitz (unpublished)]. I fully agree that there are inconsistencies even among the "positive" studies. The type of cancer showing the greatest effect varies markedly and the overall constellation of data does not all point in the same direction. Thus, the imperfect array of available data are consistent with the absence of a causal association as well as being consistent with a true, causal effect which has been clouded by methodological problems and random error.

The temporal trends and other aspects of existing literature are interpreted as indicating that a large effect of EMFs on cancer risk is unlikely, with which I also agree. Each line of evidence has a reasonable competitor to a causal interpretation, including the data from our own study. Nonetheless, the constellation of suggestive data is not easily dismissed in that postulating a true causal effect which has been diluted through poor exposure measurement can account for many (but by no means all) of the observations. The uncertainty in exposure identification pervades the literature, with most studies likely to be biased towards the null. I disagree with the assertion that "an effect must be of very low magnitude even among people who are moderately to heavily exposed" since we have yet to effectively isolate persons who have such levels of the relevant exposure.

It seems the most reasonable, unbiased reviewers of these studies come to the general conclusion that a causal effect of EMFs on human cancer has not been proven but that there are positive suggestions which should not be dismissed. There is less agreement on the more subtle questions of how close are we to proving causality, how compatible are the data with no causal association and how we should react to this uncertainty.

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UPDATES

BIOLOGICAL EFFECTS

Copper-Microwave Synergy... The latest results from the ongoing collaboration between the FDA's Drs. Jose-Luis Sagripanti and Mays Swicord and Dr. Christopher Davis of the University of Maryland in College Park indicate a synergistic reaction between microwaves and copper in damaging plasmid DNA. The researchers exposed purified plasmids – extrachromosomal rings of DNA – to 2.00-8.75 GHz radiation and found that in the presence of small amounts of copper, the radiation can lead to a statistically significant increase in single- and double-strand breaks. The effect is "linearly related to both the power applied and the duration of the exposure to MW," and, unlike the team's previous results, was observed throughout the frequency range and was not correlated with resonant frequencies, though it is possible that "the sensitivity required for detecting any resonant effects may well be out of the range of the technique used...." Microwaves alone did not affect the DNA. The researchers are emphatic that microwave heating played no part in the effect, and that their antenna did not cause any "hot spots." Follow-up studies showed that cuprous (Cu^{+}), but not cupric (Cu^{++}), ions on their own can mimic the microwave effect. The copper-microwave synergy was discovered when the researchers found that their sham-exposed sample of DNA in contact with the antenna, which was not radiating, suffered more damage than the control sample. The group cautions others to be careful in interpreting their experimental results if samples are in contact with a metallic antenna. The mechanism for the synergistic interaction remains "unclear." The team's paper appears in *Radiation Research, 110,* pp.219-231, May 1987 (see also *MWN*, May and November 1984)

COMPATIBILITY & INTERFERENCE

AM Interference...A listener survey conducted by the National Association of Broadcasters (NAB) found that while 60% of the respondents said that at sometime they heard static or interference on their AM stations, *none* of them complained to the FCC. According to the NAB, FCC officials have stated that they don't think interference is a problem because of the lack of complaints they receive from radio listeners. In a statement, NAB Radio Board Chairman Bev Brown argued, "...the public has no concept of how to complain to the FCC and no feeling that complaints will help resolve interference problems." He suggested that the FCC "establish standards to prevent interference from occurring, rather than await degradation of broadcasting that is suddenly recognized by emerging complaints."

TEMPEST Market Strong and Growing... Sales of TEMPEST computer and communications equipment will exceed $1.5 billion this year, $10 billion in 1993 and possibly $19 billion in 1997, according to a new report by International Resource Development Inc. (IRD), a market research firm. Wang has the largest share of the market, followed by IBM and DEC. IRD notes that advances in material and engineering have helped to reduce the price of TEMPEST products, but that a TEMPEST-rated PC is still more than double the unshielded price. *TEMPEST Secure Computing Equipment & Markets* (No.738) is available for $2,100.00 from IRD, 21 Locust Ave., Suite 1C, New Canaan, CT 06840, (203) 966-2525.

EMP

FCC Again Denies Petition... The FCC has dismissed a petition for reconsideration of an earlier ruling refusing to institute a notice of inquiry (NOI) on the effects of EMPs on civilian communications (see *MWN*, September/October 1986 and January/February 1987). In an order released on May 8, the FCC reaffirmed its opinion that the two petitioners, Donald Schellhardt and Nickolaus Leggett, had failed to make a *prima facie* case that an NOI would be in the public interest and that, given other ongoing efforts, an NOI would be premature. The FCC, citing support from DOD, argued that, "The sensitivity of EMPs and its national security implications weigh against a public proceeding." Schellhardt told *Microwave News* that he and Leggett have not yet decided whether to appeal the FCC decision in court.

MEASUREMENT

Revising FCC Computer Guidelines...CBEMA has proposed a "substantial revision" in the current methods of measuring radiated and conducted emissions from computer hardware as detailed in FCC's *Methods of Measurement of Radio Noise [Electromagnetic] Emissions from Computing Devices*, better known simply as *MP-4* (see *MWN*, September 1983). In an April 23 letter to FCC Chief Engineer Dr. Thomas Stanley, attorney Lawrence Movshin of the Washington, DC, firm of Heron, Burchette, Ruckert & Rothwell outlined CBEMA's suggested changes, including: (1) establishing a "method of measurement which will take precedence over other alternatives" because "the flexibility established in the original test procedures has created a number of conflicts between and among manufacturers"; (2) restating the Class A limits on the basis of a measurement distance of 10 meters because of the substantial cost of using a 30-meter test site – and eliminating the existing rules for extrapolating factors; (3) establishing a standard open area test site, which would conform to criteria outlined by CBEMA; (4) replacing the tuned-dipole antennas with linearly-polarized broad-band antennas because the latter are "significantly more efficient to use"; and (5)

deleting "all references to the need for maximizing emanations, including the need to vary cable placement during testing," because it is impossible to establish what the worst case emissions are. The complete CBEMA proposal is contained in Document No. ESC-5/87-29, April 1987, which was developed by a committee chaired by Bill DeVey of Tektronix Inc., in Wilsonville, OR. The proposal is scheduled to be discussed at the August meeting of the C63 Committee on EMC, which will he held in Atlanta, GA. For more information, contact: Charlotte LeGates, Computer and Business Equipment Manufacturers Association (CBEMA), 311 First St., NW, Suite 500, Washington, DC 20001, (202) 737-8888.

MEDICAL APPLICATIONS

NMRI Bioeffects...A group at the University of Western Ontario in London, Canada, has found that rats exposed to NMR imaging (NMRI) magnetic and RF fields experience no behavioral effects. Drs. Klaus-Peter Ossenkopp, Nancy Innis, Frank Prato and Edmund Sestini placed rats, housed in a Plexiglas chamber, inside the coils of a 0.15 T Technicare unit, using 6.25 MHz radiation, for approximately 23 minutes. The rats were tested after one or more exposures – both immediately following exposure and up to three months later. The team found no evidence of any short- or long-term behavioral changes, based on both open-field and passive avoidance learning tests. Studies on the rats' spatial memory were also negative. See the group's two papers, "Behavioral Effects of Exposure to Nuclear Magnetic Resonance Imaging: I. Open-Field Behavior and Passive Avoidance Learning in Rats" and "II. Spatial Memory Tests," in *Magnetic Resonance Imaging, 4*, pp.275-280 and pp.281-284, 1986....Dr. Frank Shellock of the Cedars-Sinai Medical Center in Los Angeles, CA, published "Biological Effects of MRI: A Clean Safety Record So Far" in the February 1987 issue of *Diagnostic Imaging*. He concludes that, "A detectable biological change caused by MRI does not necessarily indicate an adverse effect....It is known that tissue heating may occur as a result of RF power absorption during MRI and that this may be considered a biological effect. It appears, however, that temperature changes are easily tolerated by patients....It is hoped that safe levels of exposure will ultimately be established for pregnant women and operating personnel. ...Unwarranted and unsubstantiated remarks regarding the possible deleterious effects of MRI can cause unnecessary alarm and impede the progress of the technique. It is imperative, however, that appropriate precautions be taken so that the outstanding safety record of MRI can remain intact." Shellock has presented numerous papers on thermal responses to MRI fields (see *MWN*, May/June 1986). Contact: Dr. Frank Shellock, Cedars-Sinai Medical Center, Box 48750, Los Angeles, CA 90048, (213) 855-3940.

MEETINGS

Poor Turnout at EEPA... Only 65 industry officials came to the third annual meeting of the Electromagnetic Energy Policy Alliance (EEPA), April 22-24, in Washington, DC – down from 80 last year. Many of those who attended blamed the poor turnout on apathy – a surprising state of affairs given the troubles and frustrations in trying to site new facilities described by many of the speakers. For instance, Lt. Col. Paul Hanson of the U.S. Air Force said that the "lack of a national standard has significantly impacted the ability to deploy the GWEN system." By far the most rousing presentation was by Dan O'Brien of KONG-TV in Seattle, WA, who has run into opposition in his efforts to start a new television station on Cougar Mountain (see *MWN*, January/February 1986). He first applied for an FCC permit in 1980; the case is still in litigation. O'Brien said that he may appeal a permit denial all the way to the U.S. Supreme Court. He argued that the process is much more of an emotional issue than a scientific or engineering one. At one point, he said, decision makers became so frustrated that they threw up their hands, saying, "To hell with science, cut [the standard] in half." Similarly, in a discussion of EM emissions from electronic products, Dr. Walter Baker, the director of human factors for IBM, said that, "We have chaos today and we need order." Asked about the contrast between the tales of woe and the lack of interest in the meeting, many attendees said that people don't react until they have to face their own siting problems.

MILITARY SYSTEMS

Awesome Weapons..."The military potential of directed microwave beams is...awesome," writes Dr. Theodore Taylor in the April issue of *Scientific American*. In his article on "Third-Generation Nuclear Weapons," Taylor warns that, "Because the atmosphere is virtually transparent to microwaves, either the beam-generating device or the intended target could be based in space, in the atmosphere or on the earth's surface. In any event, the deployment of such weapons is likely to undermine confidence in the wartime reliability of strategic and tactical forces, including those forces that constitute the ultimate deterrent to nuclear war." Taylor also addresses the generation and propagation of EMP radiation.

OVENS

More Common than Dishwashers... In 1986, for the first time, there were more microwave ovens than dishwashers in American homes, according to MRCA Information Services, a market research firm. Nearly 60% of U.S. households now have microwave ovens, compared

to 50% with dishwashers. The spread of the ovens has been explosive: in 1982, only 26% of American homes had microwave ovens. MRCA's special report, *Microwave III*, is based on a survey of 2,000 households. Sales in 1987 continue to be strong: over 4 million ovens were shipped through the end of April, a 10% increase over the same period in 1986, according to the Association of Home Appliance Manufacturers (AHAM) in Chicago, IL. AHAM's statistics show even a larger microwave oven ownership than MRCA's estimates: AHAM projects that nearly 75% of U.S. homes will have them by the end of the year. Not surprisingly, AHAM does not expect the growth trend to continue. Some of the other statistics cited in the MRCA report include: 55 million servings of food pass through microwave ovens each day; the most commonly microwaved food is coffee; and 57% of all home-cooked baked potatoes are prepared in a microwave oven, as are 47% of home-cooked hot dogs. *Microwave III* is available for $2,275.00 from MRCA Information Services, 4 Landmark Square, Stamford, CT 06901, (203) 324-9600.

PEOPLE

Richard Tell, chief of EPA's electromagnetics branch at the Office of Radiation Programs in Las Vegas, NV, will leave the agency in September. During his 20 years with EPA, Tell, a physicist, has become well-known for his non-ionizing radiation measurement surveys, especially the recent series for the FCC in Honolulu, Portland, Seattle and Denver. Tell plans to open a consulting firm.

Dr. **Stanley Sussman** has joined EPRI's non-ionizing radiation sub-program to oversee projects on exposure assessment. **Bob Black**, who took over from Dr. **Bob Patterson** last year, will now monitor EPRI's epidemiological studies on power line electric and magnetic fields. Dr. **Leonard Sagan**, EPRI program manager for radiation studies, told *Microwave News* that a third person will soon be hired to be in charge of basic science projects, including mechanistic studies and whole animal experiments related to both teratology and cancer causation. Dr. **George Hidy**, president of the University of Nevada System's Desert Research Institute, has joined EPRI as a vice-president and director of its environment division. Hidy succeeds **Rene Males**.

After 15 years with the Naval Medical R&D Command, Dr. **Elliot Postow** has joined a Special Study Section of the National Institute of Health. Postow, the former editor of *Bioelectromagnetics*, told *Microwave News* that he plans to try to maintain as much contact with the non-ionizing radiation community as he can.

Two of the organizers of last September's international utility symposium on the effects of power line fields are moving on to new endeavors. **Bette Cantor** is leaving the Edison Electric Institute, where she has been environmental program manager, to join ICS Inc., a large Washington, DC, consulting firm, as a senior research associate. Ontario Hydro's **John O'Grady** has been promoted to a new job in the Health and Safety Division, where he will be responsible for a wide array of issues, including asbestos and PCBs. Both Cantor and O'Grady say they plan to keep up with the power line field.

STANDARDS

EIA on TV and VCR Immunity... The Electronic Industries Association (EIA) has issued a revised version of its Interim Standard (IS), *Immunity of Television Receivers and Video Cassette Recorders (VCRs) to Direct Radiation from Radio Transmissions, 0.5 to 30 MHz*. IS-16-A replaces IS-16, which was published in 1985 (see *MWN*, September/October 1985). The new standard retains the same immunity levels as IS-16: 1 V/m for AM broadcast, amateur radio and CB bands, and 0.3 V/m for other frequencies. The major change is that VCRs in the playback mode must now be immune to these levels between 500 kHz and 7.5 MHz; it applies to new chassis designs for VCRs in production after May 1989 and all VCRs after May 1991. Note that the EIA standard does not apply to miniature TVs or to portable, battery-operated VCRs. IS-16-A, which was developed by the EIA R-2 Committee on Consumer and Electromagnetic Compatibility, chaired by Howard Lester of GE, includes a section on measurement methods. Copies of IS-16-A are available for $7.00 each from the EIA Standards Sales Office, 2001 Eye St., NW, Washington, DC 20006, (202) 457-4966.

CISPR on EMI Measurements... The International Special Committee on Radio Interference (CISPR) has just published the second edition of its international standard, *CISPR Specification for Radio Interference Measuring Apparatus and Measurement Methods*, Publication 16. The 228-page document, written in English and in French, covers both conducted and radiated EMI and includes measurement techniques for domestic appliances, radio and TV receivers and ISM equipment. In addition, it details how to gauge the total radiated power from equipment operating in the microwave frequency range – 300 MHz-18 GHz – using a reverberating chamber and discusses statistical considerations for ensuring that mass-produced appliances meet EMI rules. The publication contains 19 appendices; topics include power line interference, pulse generators, spectrum analyzers and field measurements. The standard is available for $139.10, prepaid, which includes postage and handling, from: ANSI, International Sales Department, 1430 Broadway, New York, NY 10018, (212) 642-4900.

VDTs

AMA on Health Effects...VDT use is not associated with reproductive or radiation risks, according to a report by an American Medical Association (AMA) panel. Citing some of the VDT epidemiological studies, the panel concludes that none of the work "could support an association between exposure and adverse outcome." The paper, "Health Effects of Video Display Terminals," appears in the *Journal of the American Medical Association, 257*, pp.1508-1512, March 20, 1987.

Mt. Sinai Study Design... Researchers at the Mount Sinai School of Medicine in New York City have completely redesigned their proposed prospective epidemiological study of reproductive risks among VDT workers. Their principal objective now is to investigate the miscarriage risks associated with *office work* in general, not just VDTs. According to Dr. Michele Marcus, the coordinator of the study, the planned cost of the project has more than doubled – at least partly because it will no longer rely on volunteers to recruit participants. In addition, an extremely sensitive urine test will be used to detect miscarriages. The Mount Sinai study was first announced two years ago by Dr. Irving Selikoff, a world-renowned expert on occupational health (see *MWN*, June 1985). Soon afterwards, following Selikoff's retirement, Dr. Philip Landrigan took over as head of Mount Sinai's Division of Environmental and Occupational Medicine and became the co-principal investigator. The study has not yet received funding.

ETC...

Magnetic Senses... Can dowsers detect tiny anomalies in the Earth's magnetic field? Tom Williamson outlines the historical record for and against dowsers in the cover story of the March 19 *New Scientist*. Williamson is sympathetic to the proposition that humans, like many other species, have a magnetic sensitivity. He notes that researchers have calculated that the yellowfin tuna's magnetic sensors can detect changes in the magnetic field as small as one nanotesla....Two University of Washington, Seattle, zoologists report that a marine mollusk derives directional information from the Earth's magnetic field. See Drs. Kenneth Lohmann and Dennis Willows's paper in the January 16 *Science*.

Speeding Jets... Whistler Corp.'s police-radar detector was recruited for a special electronic warfare mission in 1979. After the Shah was chased out of Iran, the U.S. Navy had to find a quick way to protect its fighter and attack jets from its own Hawk missiles. The solution, according to the Associated Press (May 5): the Navy purchased about 750 detectors, for approximately $180 each, and had them modified – at a cost of about $2,500 each – at the Naval Weapons Center at China Lake, and then mounted them on the aircraft dash with Velcro. It was supposed to be a stopgap measure, but a Defense Department source conceded that some of the units are still in use. The May 18 *Aviation Week* added that the detectors will be phased out within the next two years.

Conference Calendar

New Listings

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

September 23-25: **1987 Symposium on Antenna Applications**, Allerton House, Monticello, IL. Contact: Paul Mayes, Dept. of Electrical and Computer Engineering, University of Illinois, 1406 W. Green St., Urbana, IL 61801, (217) 244-0543.

September 29-October 1: **9th Annual Meeting and Symposium of the Antenna Measurement Techniques Association**, Stouffer Madison Hotel, Seattle, WA. Contact: James Otey, 6632 South 191st Place, Suite E-105, Kent, WA 98032.

October 23-25: **Magnetic Resonance Imaging**, Marriott Hotel, Washington, DC. Contact: Patrice Rapalus, *Diagnostic Imaging*, 500 Howard St., San Francisco, CA 94105, (415) 397-1881.

January 31-February 5, 1988: **1988 Winter Meeting of the IEEE Power Engineering Society**, Penta Hotel, New York, NY. Contact: IEEE Society Special Services, 345 East 47th St., New York, NY 10017, (212) 705-7895.

April 20-21, 1988: **IEEE 1988 National Radar Conference**, Ann Arbor, MI. Contact: University of Michigan Extension Service, Department of Conferences and Institutes, 200 Hill St., Ann Arbor, MI 48104, (313) 764-5304.

Honolulu (continued from p.1)

town Honolulu because local zoning rules have barred them from the surrounding hills to preserve scenic beauty (see *MWN*, April 1984).

The report has attracted very little interest. Robert Hall, who has actively sought government attention to the RF radiation issue, told *Microwave News* that he had mailed a copy of the report with additional background information to the Governor, to every member of the Hawaiian congressional delegation, to every state representative and to every major radio and television station and newspaper, but that not a single person has responded. Hall, who heads the Hawaii Institute for Biosocial Research, is also calling for "all sources of radiation" to be moved "from where people live and work."

A 1984 radiation survey of Honolulu by the Environmental Protection Agency (EPA) and the Federal Communications Commission (FCC) identified the highest levels of RF radiation ever measured in an urban area (see *MWN*, January/February 1985). Last year, the Honolulu City Council adopted a zoning regulation that bars the construction of new broadcast towers in residential and business districts (see *MWN*, November/December 1986). (continued on p.15)

The age- and race-adjusted cancer rates (1979-1983) among males in eight of nine census tracts with radio and television towers were significantly higher ($p<0.01$) than the rates expected on the basis of state statistics, according to the Anderson-Henderson report. In one tract, the number of reported cases was three times greater than expected. The cancer data were obtained from the Hawaii Tumor Registry.

The overall adjusted rate among women during the same period was also significantly higher than expected – but this only held true for two specific tracts. The rates of leukemia were also higher in tracts with RF sources, though not at the 0.01 level of significance. The number of cases was small.

Anderson and Henderson, who are with the health department's environmental epidemiology program, cited a number of limitations to the study, including the lack of detailed exposure data, possible confounding effects of other carcinogenic agents and the transiency of the study population.

Dr. William Morton, a professor of environmental medicine at the Oregon Health Sciences University in Portland, told *Microwave News* that the Honolulu study is a "reasonable pilot study" and is "definitely an indication that further research should be undertaken." Morton, who uncovered a correlation between cancer incidence and RF broadcast radiation in Portland, said that the Honolulu survey supports his own observations (see *MWN*, January/February and May 1982).

Lualualei *(continued from p.1)*

plained in a telephone interview from his office in Honolulu, because the number of cases was small and because exposures from the radio antennas would have been hard to estimate due to the Navy's frequent changes in frequency and power output. "If the rates had continued to increase, we would have pressed for a study," he said.

LeMarchand pointed out that even though the four cases of acute lymphoid leukemia and the five cases of acute myeloid leukemia were unexpected, small clusters of leukemia do occur by chance.

The Radio Transmitter Facility (RTF) at Lualualei has been a source of friction between local residents and the Navy for many years. In 1982, Citizens Concerned for the Future of Our Children challenged the Navy, raising concerns over the possibility that radiation from the antenna farm – which includes a 1-2 million watt very low frequency (VLF) transmitter – was increasing the incidence of cancer and hyperactivity among the children in the community (see *MWN*, July/August 1982).

In a 1982 letter to U.S. Senator Spark Matsunaga, the group asked that a health study of those living near the Lualualei RTF be carried out by CRCH. The health survey was never done; instead, the radiation levels inside the Navy complex and on its border were measured by Boynton Hagaman of Kershner & Wright, a consulting engineering firm based in Springfield, VA, as well as by Navy personnel.

On the basis of those measurements, the Navy's Bureau of Medicine and Surgery in Washington, DC, concluded that "there is *no* reason to believe" that people living outside the RTF boundary are suffering any adverse biological effects from electromagnetic radiation (Navy's emphasis).

In a recent telephone interview, Dr. Fred Dodge of the Wai'anae Coast Comprehensive Health Center, one of those who signed the letter to Senator Matsunaga, said that there was less than complete confidence in the Navy's radiation survey because of the Navy's refusal to extend its measurements into the nearby community. In addition, he said, the Navy refused to specify the power levels coming from the antennas at the time of the survey. According to Dodge, the radiation issue in the community next to the Lualualei RTF is "dormant but not dead."

At a Pearl Harbor news conference held in July 1982, Professor Bill Guy of the University of Washington in Seattle reassured local residents that their alarm was "totally unwarranted," according to a report by the *Honolulu Star-Bulletin*.

LeMarchand was not at the cancer center in 1982. He said that a local physician, who suspected that the rates of leukemia were abnormally high, brought the cluster to his attention.

At the time the measurements were made in 1982, the RTF had one VLF antenna consisting of two 1,500-foot towers operating at 22-23 kHz, one low frequency (LF) 450-foot antenna operating at 146.1 kHz and several high frequency (HF) antennas operating at various frequencies in the 3-30 MHz band. There were also a number of microwave (MW) towers. According to the survey, the highest radiation levels at the RTF's boundary fence were: 83 V/m for VLF; 1.35 V/m and 4.16 mA/m for LF; for HF radiation, the levels were at least 16 times (24 dB) less than the ANSI standard (63 V/m at 30 MHz and 632 V/m at 3 MHz); and for MW, less than 10 $\mu W/cm^2$. Inside the base, the maximum measured VLF electric and magnetic fields were 972 V/m and 3.81 A/m, respectively; for LF, they were 114 V/m and 23.4 mA/m, respectively.

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VDT Use Linked to an Increased Miscarriage Risk

Women who used video display terminals (VDTs) more than half the workweek during the first three months of pregnancy were more likely to suffer miscarriages than those doing other types of office work, according to a new epidemiological study from Kaiser Permanente in Oakland, CA. Their offspring also had an increased rate of birth defects, though this finding was not statistically significant.

In the June issue of the *American Journal of Industrial Medicine*, Kaiser's Marilyn Goldhaber, Michael Polen and Dr. Robert Hiatt report that clerical workers who used VDTs more than 20 hours a week had more than twice as many miscarriages as women who performed similar tasks without VDTs. Kaiser provides health care and medical coverage to approximately two million members.

"I don't think these are definitive findings, but we did identify a statistically significant association," Goldhaber told *Microwave News*, "The VDT-pregnancy issue needs more research." She added that her study was not designed to determine the causes of the miscarriages. "Not much is known about low-frequency, low-intensity magnetic fields, so we can't rule them out, nor can we eliminate the possibility that poor working conditions are responsible; and there is always the chance that the association is spurious," she said.

(continued on p.13)

ELF and the Pineal Gland: Cancer and Depression

The pineal gland is at the center of new hypotheses on the role of extremely low frequency (ELF) fields in the development of cancer and depression. Neurochemicals which are associated with the pineal have been linked – either directly or through their metabolites – to tumor formation and suicidal behavior.

To be sure, the links are still far from proven, but as Dr. Bary Wilson of the Battelle Pacific Northwest Labs in Richland, WA, said in a telephone interview, the data are "equivocal, but highly suggestive" of a major role for the pineal gland in a number of electromagnetic field (EMF) effects.

As early as 1981, researchers at Battelle reported that ELF electric fields can affect the hormones secreted from a rat's pineal gland. In June, at the *Annual Meeting of the Bioelectromagnetics Society* (BEMS), Battelle's Dr. Fred Leung will report that rats which *respond* to a cancer-causing chemical develop more mammary tumors when exposed to ELF

(continued on p.14)

ELF NEWS

« Power Line Talk »

Consulting on power line health effects can be very lucrative. Dr. **H.B. Graves,** now chief scientist at Crowell & Moring, a Washington, DC, law firm, and formerly a professor at Pennsylvania State University, made over $75,000 (U.S.) in six months as a consultant to the Health Department of Victoria in **Australia.** Graves reviewed the State Electricity Commission of Victoria's plans for the now-canceled **Brunswick-Richmond** line, paying special attention to the health risks associated with EMF exposure. According to documents released under the local equivalent of our Freedom of Information Act, Graves spent more than 850 hours on the job from October 1985 to March 1986, billing at the rate of $90/hour. During one marathon week in February, Graves made close to $7,000. In addition, he claimed approximately $10,000 in expenses, including $4,124 in airfare for his trip to Australia.

«« »»

It is likely that the **Department of Energy** (DOE) will have more money for research on the biological effects of power line fields in 1989. The **House energy and water development subcommittee** of the Appropriations Committee has increased DOE's budget from the $2.2 million requested by the Reagan Administration to $4 million. The new money is largely due to the efforts of Rep. **George Brown** (D-CA). The Senate has yet to act; any differences would have to be addressed later in a House-Senate conference. Still, one senior DOE official is optimistic. "There's a good chance the increase will pass," he said.

«« »»

A September 8 trial date has been set for the $60 million **Marcy-South** power line lawsuit filed in January 1987 against the New York Power Authority (NYPA) (see *MWN*, March/April 1987). Landowners are claiming that the 345 kV line will create a "cancerphobia" corridor which will destroy the market value of their property. They want the NYPA to establish a right-of-way (ROW) of 2,400 feet, thereby limiting magnetic field exposures to a maximum of half a milligauss. **Michael Gurda** of Gurda, Gurda & McBride in Middletown, NY, will be representing many of the plaintiffs. NYPA's attorneys will include **Tom Watson** of Crowell & Moring. In mid-May, the NYPA announced that the entire 207-mile Marcy-South line was being energized for testing.

«« »»

In an April 2 editorial following the March 21 broadcast of the **BBC's** ***Panorama*** program on power line health risks, ***The Lancet,*** one of the world's leading medical journals, chastised the U.K.'s **Central Electricity Generating Board** (CEGB) for not spending enough money on research. The editors wrote that the £500,000 ($940,000) budget is "nowhere near enough to support the studies, in the laboratory and by epidemiologists, that will be needed to resolve the question." Dr. Robin Cox, the CEGB's chief medical officer, issued a prompt reply – published in the journal's April 23 edition – noting that the board's new commitment of £500,000 actually represented a doubling of its budget on EMFs and that it had spent £3.5 million ($6.5 million) on the problem over the past eight years. A commentary by Dr. Neville Goodman in the April 9 issue of the ***British Medical Journal*** called the documentary "well balanced" and praised those interviewed for not being "dogmatic." This appraisal was in stark contrast to accusations in Parliament that the show had engaged in scaremongering. Part of the problem is no doubt related to the fact that a move is underway in the U.K. to take the CEGB private and there are concerns that no one will want to buy the national electrical grid if it is believed to cause cancer. **Tom Mangold,** the reporter for *Panorama's* "Electricity – A Shock in Store," presents an overview of his thinking in an article, "The Killing Fields," in the March 24 issue of *The Listener.*

«« »»

There is continuing comment on Dr. **Ken Foster** and **Bill Pickard's** proposal to put an end to research on hazards associated with non-ionizing radiation (see *MWN*, January/February 1988). Writing in the May 5 issue of ***Nature,*** French researcher Dr. **Janine Perre** endorses their view. Perre, who has collaborated on 50 Hz electric field studies with scientists from Electricité de France, the French utility, wonders if the editors and reviewers of major scientific journals have a tinge of ambivalence "when confronted with a manuscript dealing with possible dangers of industrial agents, an ambivalence arising perhaps from a fear of being accused of selling out to international capitalism." Look for more letters in future issues of *Nature.*

«« »»

The report of the **Canadian Working Group on Electromagnetic Fields,** due to be released in February, is still not out. The group was formed after union officials raised concerns over health risks associated with ELF fields (see *MWN*, November/December 1986 and May/June 1987). The report

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has been held up by a host of procedural and bureaucratic delays, according to the group's chair, Dr. **Maria Stuchly** of the Canadian Radiation Protection Bureau. But she said that the report will be released at the end of the summer.

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Here is the latest on **Florida's power line siting rules.** Following the April 14-15 meeting of the Environmental Regulation Commission, the state Department of Environmental Regulation (DER) proposed EMF standards at the edges of rights-of-way: 1.5 kV/m for the electric field and 50 mG for the magnetic field, under average load conditions, and 100 mG under maximum loadings. These limits are essentially the same as those recommended by the Florida EMF Advisory Panel last year (see *MWN*, November/December 1987). A public workshop has been scheduled for June 7, and another will be held in July. The standards will apply only to new power lines. "Old lines will operate as they are," DER's **Buck Oven** said. This would save a lot of retrofitting because, as Oven pointed out, the vast majority of the existing 500 kV lines do not now conform to these limits; nor do more than half of the existing 230 kV lines. Even some of the 138 kV lines do not comply. Under the current schedule, final rules could be adopted in October but, as Oven indicated, the date they would take effect is another issue still to be determined.

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As expected, on April 12, the **New York Public Service Commission** (PSC) decided to keep its power line 1.6 kV/m **electric field standard** (see *MWN*, March/April 1988). At the same time, the commission ordered the development of an interim magnetic field standard. The PSC also called for state utilities to participate in a technical conference to help set the magnetic field limit and to determine the magnetic fields generated by 345 kV power lines. (In its January 11 task force report, the PSC recommended setting the limit at 100 mG.) The conference, which will be open to the public, will not consider the bioeffects of magnetic fields. As the PSC argued in an April 12 order: "The interim standard will not be directly related to biological effects," because "magnetic fields have not been shown to be hazardous and...the purpose of any standard would be to ensure that exposures to magnetic fields in future transmission line designs would be no greater than those which now exist for the many 345 kV lines operating for years throughout New York state."

«« »»

The opening plenary session at the **July Power Engineering Society meeting** in Portland, OR, will be an update on EMFs. Among those scheduled to speak are the VA's Dr. Ross Adey, HHS's Dr. John Bailar, DOE's Ken Klein and EPRI's Dr. Leonard Sagan. And this year's annual **DOE-EPRI EMF research review** will be held October 30-November 3 in **Phoenix, AZ.** The meeting is open to all and there is no registration fee. A special room rate of $46.00 is available to attendees. For additional information on both meetings, see the conference calendar on p.15.

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The transcript from last October's **Congressional hearings** on ***Health Effects of Transmission Lines*** is back from the printer and can now be ordered. The hearing record includes both the testimony of the expert witnesses and their answers to questions posed by Rep. **George Miller** (D-CA), the chairman of the House subcommittee on water and power resources (see *MWN*, September/October 1987 and January/February 1988). The transcript also includes a number of interesting papers, articles and letters concerning EMF effects. Lauri Sonken, the staff aide who organized the hearings, recently left the subcommittee to return home to Los Angeles. Copies of the transcript are available for $11.00 each from: the Superintendent of Documents, Government Printing Office, Washington, DC 20402. Specify stock No.052-070-06461-7. Visa and Mastercard orders are also accepted; call (202) 783-3238.

Wertheimer & Leeper: Adult Study Links EMFs and Cancer

A major epidemiological study does link adult leukemia and exposure to extremely low frequency (ELF) electric and magnetic fields (EMFs) at home, according to a new analysis by Dr. Nancy Wertheimer and Ed Leeper. Researchers at the Battelle Pacific Northwest Labs in Richland, WA, originally reported no association in their study, which, like the Savitz childhood study, was supported by the New York Power Lines Project (NYPLP).

Battelle's Dr. Richard Stevens found no significant increased risk of acute non-lymphocytic leukemia (ANLL) among those exposed to the greatest EMFs, as compared to controls (see *MWN*, November/December 1986). Wertheimer and Leeper believe that, in fact, the study supports their hypothesis that magnetic fields are cancer promoters.

Wertheimer and Leeper have refined the Battelle analysis by taking into account the chronic use of electrically-heated beds – electric blankets, waterbed heaters and electric mattress pads – which are common sources of magnetic fields in the home. "Because Stevens's group collected extensive data on the use of these appliances, we were able to assemble a better control population – one that was unexposed to EMFs from either power lines or electrically-heated beds," Wertheimer told *Microwave News*.

Using this new control group and making other refinements, Wertheimer and Leeper reworked the Battelle data and found that the risk of leukemia increases 50-90% if an individ-

ual has been exposed to EMFs from *either* power lines or electrically-heated beds, and up to 110-260% if exposed to EMFs from *both*. When a comparison is made with those exposed to neither source of EMFs, the estimates are either borderline or fully statistically significant at the 95% confidence limit.

Wertheimer, a professor in the Department of Preventive Medicine at the University of Colorado in Denver, and Leeper, a freelance consultant based in Boulder, CO, also argue that the number of cases in Battelle's highest exposure group was too small to allow for meaningful comparisons. "When we collapsed the study's four exposure categories into 'high' and 'low' exposure groups, a positive trend emerged," Wertheimer said.

Indeed, in his report to the NYPLP, Stevens pointed out the study's limitations due to both the small sample size and the possible misclassification of exposures. "I would not rule out an association between adult leukemia and residential exposure to ELF fields on the basis of our study," he said in a recent telephone interview.

Dr. David Carpenter of the New York Department of Health, who served as the executive secretary of the NYPLP, agreed that the issue is not closed. "There is no reason to believe that, if magnetic fields are linked to cancer, the effect is limited to children," he told *Microwave News*.

Wertheimer, Leeper, Stevens and Carpenter all support further research. "We've got to do more studies on adult residential exposures," Stevens said.

Wertheimer and Leeper argue that, if magnetic fields and cancer are causally linked, well over 25% of the ANLL cases in the Battelle study may be attributable to EMFs from high-current power lines, especially electrically-heated beds. They emphasize that exposures from appliances like electric blankets are avoidable: "*Individuals* can mitigate any cancer risk inherent in EMF exposure by altering their use."

A copy of Wertheimer and Leeper's comments is available for $3.75 from: Charlene McAuliffe, NYS Department of Health, School of Public Health, Corning Tower, Room 2517, Empire State Plaza, Albany, NY 12237, (518) 474-7888. Make the check payable to Health Research, Inc.

States Seek Power Line Rules in Face of Federal Inaction

Interest in power line safety is heating up in state houses around the country. Eight months after Representative George Miller (D-CA) held hearings, the U.S. Congress appears reluctant to tackle the power line issue. As a result, the regulation of power line extremely low frequency (ELF) fields may follow the same path as that of radiofrequency and microwave radiation; that is, in the absence of federal rules, state and local governments will adopt their own exposure standards.

Although only one bill has made it into law – James Seward's measure in New York State – a number of proposals have been introduced in state legislatures. Here is a state-by-state review.

New York

The most specific proposal to regulate electromagnetic fields (EMFs) was introduced by Assemblyman Richard Brodsky on March 29. His bill, No.10427, would require that:

- No new residential building be built within 25 feet of an above-ground power line, or within 50 feet of a 23 kV or greater line;
- No new above-ground power line be built within 25 feet of a residential building;
- No new 23 kV or greater above-ground power line be built within 50 feet of a residential building;
- No new power line or residential building be built such that a power line magnetic field of 2.5 mG or greater is present anywhere in the residence.

The exposure levels were derived from the Savitz study, according to Mike Ettlinger, a legal advisor to Brodsky. "There's enough science there to create a strong suspicion that a real problem [exists]; in the meantime, we shouldn't be building new facilities that are likely to prove harmful," Ettlinger told *Microwave News*.

The bill has been forwarded to the Assembly's Corporations Committee, where it awaits a hearing.

Under a law passed in July 1987, the Public Service Commission cannot grant a certificate of construction or operation to a major utility transmission facility unless it determines that the facility has the minimum environmental impact on agricultural lands, wetlands, parklands and river corridors. The bill, No.1947-A, was sponsored by Senator James Seward.

Rules to limit workers' access to within ten feet of high-voltage power lines were proposed by Senator James Lack. As of early May, Lack's bill, No.7782, which would exempt power line construction and maintenance work, was on hold pending "additional amendments."

Under a bill, No.8831, introduced by Assemblyman Gordon Burrows, whenever possible, utilities would have to locate high-voltage power lines on state-owned lands – specifically, highway rights-of-way. The bill has passed the Assembly's Energy Committee and is now before the Rules Committee. A companion measure has been introduced by Senator Guy Vellela.

California

The Public Utilities Commission (PUC) and the Department of Health Services would conduct a joint study of cancer and any other health risks associated with EMF exposure from power lines, under a proposal introduced by Senator Herschel Rosenthal.

A spokesman for Rosenthal said that the purpose of the

proposal, No.2519, is to "make sure that the state has an independent evaluation of EMF health risks," and that it does not have to rely on studies sponsored by power companies. The bill would require all state utilities with operating revenues of $25 million or more to contribute to a newly created EMF study fund – the total collected could not exceed $2 million. A status report would have to be filed by December 1, 1989.

The bill was prompted by the report from the New York Power Lines Project. The legislature felt that, in light of the Savitz study, it should take some action to establish whether exposure to EMFs produced by power lines presents an "unreasonable cancer risk," and whether regulations are needed to curb that danger, an aide to Rosenthal told *Microwave News*.

Supporters of the bill include the American Cancer Society, the International Brotherhood of Electrical Workers and the Parent Teachers Association. The PUC is also in favor of the proposal, arguing that more evidence – refuting or confirming the health risk – is needed before imposing the costs associated with implementing EMF rules.

The senate's Committee on Energy and Public Utilities approved the bill unanimously on May 3 and forwarded it to the Appropriations Committee.

The PUC is getting ready to start a survey of the status of current EMF research and future research needs. The governor has allocated $100,000 in his 1988-1989 budget for this effort, which is scheduled to begin this summer.

Washington State

Municipally-owned utilities would have to bury those parts of power lines of 200 kV or more that extend beyond city limits, if the population density is at least 100 people per square mile and if the lines pass within 2,000 feet of any residence, according to bill No.6110, introduced in January by Republican Senator Eleanor Lee. The bill was prompted by complaints from residents living outside city limits, who currently have little control over municipal utilities.

The bill received a public hearing in the Senate Energy and Utilities Committee but, as a result of the cancellation of a local utility's plans for a 230 kV line, did not come up for a vote. Instead, the committee called for an interim study on ELF health risks. Lee told *Microwave News* that she plans to introduce a revised version of her bill in the next session, which begins in January 1989.

Another proposal, which also did not emerge from committee, would have prohibited state utilities from erecting high-voltage (in excess of 200 kV) electric transmission lines unless there was "no reasonable doubt that the health and safety of the persons working or residing in the area...are adequately protected." This bill, No.6421, was introduced by Democratic Senator Phil Talmadge.

Fran Raney, an aide to Senator Lee, said that Lee's and Talmadge's bills may be combined in the future.

Virginia

Since 1985, the Virginia legislature has required an annual report on the health effects of high-voltage transmission lines (see *MWN*, May 1985 and January/February 1986). The reports, prepared by the Department of Health and the State Corporation Commission, summarize recent studies on power line safety. The third annual report, issued in October 1987, concludes that, "There is a paucity of data to indicate that...

State Guidelines for Siting Power Lines and Schools

The Klein (Texas) School District lawsuit against Houston Lighting & Power Co. has focused much attention on the siting of schools near power lines and vice versa. Now, the California Department of Education has proposed what may be the first state guidelines addressing this issue.

The interim policy of the department's School Facilities Planning Division was prompted by studies on both electromagnetic fields (EMFs) and corona effects. It calls for a minimum distance – which varies according to a line's voltage – between the edge of a school's property and the edge of a right-of-way (ROW):

100 feet from a 100-110 kV ROW
150 feet from a 220-230 kV ROW
250 feet from a 345 kV ROW

Other factors that are considered include the possibility that a utility might later increase the voltage or expand a line, as well as non-power line issues.

According to Dr. Bruce Lowrey, a consultant to the planning division, the separation distance used to be a minimum of 400 feet, but the policy was relaxed after reviewing data from the Electric Power Research Institute and from the IEEE Power Engineering Society.

Meanwhile, in Florida, Senator Don Childers has introduced a bill which would stipulate a minimum distance of 400 feet between a school and the edge of a power line ROW. The bill, No.1165, which is patterned after California's original policy, has passed the Education Committee and is now before the Natural Resources Committee.

An aide to Childers told *Microwave News* that the senator is pushing hard to get the measure approved. CEASE (Citizens Endorsing A Safer Environment), a Boca Raton-based action group opposing the siting of a local school within 230 feet of two existing 230 kV power lines as well as one 138 kV line, is also pressing for the bill's passage.

electromagnetic fields...can propagate an adverse pathological effect...in humans."

For a copy of the 1987 annual report, contact: Dr. Khizar Wasti, Bureau of Toxic Substances, Department of Health, James Madison Bldg., 109 Governor St., Room 918-922, Richmond, VA 23219.

Measurement Roundup

• The Magnetic Fields Task Force associated with the IEEE Power Engineering Society (PES) released its report, *Magnetic Fields from Electric Power Lines Theory and Comparison to Measurements*, at the society's annual meeting the first week of February.

Among the conclusions of the report are:

> The location of the return current (not if it exists but where it exists) is the most crucial influence on the magnitude of the magnetic field of the power system in areas where human exposure is most likely. The closer physically that this current is to the power line, the less the magnetic field at ground level.
>
> Buried pipes often carry sufficient 60 Hz current to substantially change the ground level magnetic field.
>
> The magnetic fields near distribution lines may be comparable to *or even larger* than the magnetic fields near overhead transmission lines. [emphasis added]
>
> The magnetic fields of buried cables may exceed those of an overhead power line carrying the same currents. This is because the earth is not a good magnetic field shield at 60 Hz.

The principal authors of the report are: Rod Baishiki of Pacific Gas and Electric Co., Dr. Don Deno of General Electric (GE) and Dr. Robert Olsen of Washington State University in Pullman. The task force is an offshoot of the AC Fields Working Group, which in turn is part of the Corona and Field Effects Subcommittee of the Transmission and Distribution Committee.

A copy of the report (88 WM 078-8) is available for $3.00 (IEEE members), $6.00 (nonmembers), prepaid, from: Single Publication Sales Dept., IEEE Service Center, 445 Hoes Lane, PO Box 1331, Piscataway, NJ 08855.

• A team of Swedish researchers has found that the 50 Hz magnetic fields in Swedish residential housing agree with the results found by U.S. teams in Colorado and Washington state and by English studies. Dr. Kjell Hansson Mild of Sweden's National Institute of Occupational Health in Umea told *Microwave News* that his results, based on both short-term measurements in 54 homes and 24-hour readings in 20 residences, are consistent with the previous work.

According to a report in the institute's newsletter (dated 3/87), the measurement project found that "in most residences" the magnetic field is less than 0.1 μT and that fields greater than 1 μT are "found only in exceptional cases" – and that, "In cases where the residence is close (<50 m) to a power line carrying a high current, the externally-generated magnetic field will be the dominant contribution to the general magnetic field levels in the residence."

• The International Electrotechnical Commission (IEC) has issued a new standard, *Measurement of Power-Frequency Electric Fields*, which covers instrumentation, calibration and field strength determination.

Written by the IEC High-Voltage Testing Techniques Committee (No.42), the document includes an appendix on "Parameters Affecting Accuracy of Field Strength Measurements."

Copies of the 45-page standard (IEC 833: 1987), which is in English and in French, are available for $38.00 each from: Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018, (212) 642-4900. All orders must be prepaid.

• The electric fields from different types of 345 kV power lines can vary considerably. "Each type has its own footprint," Dr. David Bruening of the Omaha Public Power District told *Microwave News*. In general, he said, "The higher the conductors, the lower the ground-level electric field."

In a paper in the October 1987 issue of *Right of Way*, Bruening compared the measured and calculated fields from four types of 345 kV structures: lattice towers, tubular H-frames, wooden H-frames and single steel poles. And he found that the maximum fields for a wooden H-frame are approximately 40 feet from the center of the structure, but that they are at the center of the line for the lattice tower and for the single steel pole.

In general, there was good agreement between the measured and calculated values – usually within 5%, with a maximum difference of 15-20%, Bruening said. The electric fields were calculated with a program devised by the Bonneville Power Administration. Bruening added that the calculations were in the process of being repeated using EXPOCALC, developed by the Electric Power Research Institute (EPRI).

Right of Way is published by the International Right of Way Association, 9920 La Cienga Blvd., Suite 515, Inglewood, CA 90301, (213) 649-5323.

• EPRI has released an expanded version (2.1) of EXPOCALC – which allows users to predict exposures to magnetic, as well as electric, fields.

The program operates on IBM PC-compatible microcomputers. EPRI is already planning the next version of the program, which will permit analysis of multiple AC lines in the same right-of-way.

For more information, contact: EPRI's Office of Special Projects, (415) 855-2974.

EPRI's Dr. Stanley Sussman, who is the project manager for the development of EXPOCALC, has written an article in the March 1988 *EPRI Journal* on "Electric and Magnetic Field Exposure Assessment," which provides information on the EXPOCALC software as well as on Emdex, a small instrument worn on the body that measures and records field strengths and

then displays the data on a PC.

• GE's Don Deno, who designed and built the prototype of the Emdex measurement system and originated the leading 60 Hz meter (the "Deno Meter"), has just started marketing an inexpensive 60 Hz magnetic field sensor.

The Model 116 can be plugged into any standard digital multimeter – such as the 3.5 digit Fluke 8020 or the 4.5 digit Fluke 8060. It can also be used to measure magnetic fields from 0.01 milligauss to 25 gauss.

The Model 116 costs $77.00 (including shipping and handling). Contact: Electric Field Measurements, PO Box 326, Rt. 183, W. Stockbridge, MA 01266.

• Integrity Electronics & Research Co. is marketing a 60 Hz magnetic field dosimeter. The portable battery-powered 3"x4"x7" unit can measure fields from 1 microgauss to 2 gauss – on four scales – with a ±2% accuracy in any range. It has an LCD digital readout, with an 11 Hz bandwidth from 55-66 Hz.

Tom Valone, Integrity's president, told *Microwave News* that demand for the new unit, No.IER-109, is surpassing production and that the company has over $10,000 in backlogged orders – without any advertising. He added that Integrity is in the midst of planning a large-scale marketing effort in North America and in Europe.

The dosimeter costs $350.00 and is available from: Integrity Electronics & Research Co., 558 Breckenridge St., Buffalo, NY 14222, (716) 886-6985. The company also markets an ELF spectrum analyzer ($2,700.00) and a charge amplifier/ion current meter ($275.00).

• EPRI is sponsoring a seminar on *Power-Frequency Electric and Magnetic Field Exposure Assessment*, October 12-14 at the Red Lion Inn in Colorado Springs, CO. The current seminar fees are $125.00 for EPRI members and $600.00 for non-members. Fees go up on August 1 and no registrations will be accepted after September 15.

The seminar will feature technical sessions, panel discussions and exhibits. For more information, contact: Robert S. Banks & Associates, PO Box 14574, University Station, Minneapolis, MN 55414, (612) 623-4646.

• Virginia Electric Power Co. (VEPCO) has turned a 27-foot recreation van into a mobile electromagnetic compatibility (EMC) lab for dealing with power line interference. The utility outfitted the van, which includes a 30-foot telescopic rooftop mast, with $200,000 worth of equipment from Electro-Metrics of Amsterdam, NY.

The van will help the utility address interference to television reception. VEPCO will be able to measure power line fields before, during and after the construction of a transmission line. The equipment can even record television programs in specific locations to document the quality of reception.

According to a spokesman for Electro-Metrics, 25 utilities have bought similar equipment – without the van. .

HIGHLIGHTS

DOD Shuts Down EMP Simulators

The Department of Defense (DOD) has shut down many of its electromagnetic pulse (EMP) simulators pending the completion of environmental assessments. The move was dictated by a legal agreement to settle a year-old suit filed by the Foundation on Economic Trends, an environmental group based in Washington, DC, under the leadership of Jeremy Rifkin.

Under the May 13 agreement, approved by U.S. District Court Judge John Garrett Penn, the U.S. Navy will stop using its first EMP simulator for ships (EMPRESS I) and the U.S. Army will stop using its EMP simulators at the Harry Diamond Labs in Virginia, at the Redstone Arsenal in Alabama and at the White Sands Missile Range in New Mexico until they meet the requirements of the National Environmental Policy Act (NEPA). NEPA dictates the preparation of environmental impact statements (EISs) for "major federal actions."

In addition, while the Navy assesses the environmental impact of its TACAMO EMP (TES) and NAVES II simulators at the Naval Air Station in Patuxent River, MD, the electromagnetic fields (EMFs) from their operation must be less than 1 kV/m at the boundaries of the facilities.

The 1 kV/m limit is a compromise that neither Rifkin nor the DOD endorses: The agreement states that Rifkin does not accept it "as a verified standard adequate to protect either public health or the human environment," while the DOD holds that the 1 kV/m limit is "extremely conservative and has been used only as a settlement tool."

The agreement also stipulates that the Army will no longer simultaneously operate its Repetitive EMP Simulator (REPS) and the Army EMP Simulator Operations (AESOP) units at the Harry Diamond Labs in Woodbridge, VA.

Negotiations toward the settlement of Rifkin's suit (see *MWN*, March/April 1987) began in April after motions were filed to interview two civilian employees of the Diamond labs. Sources told the *Washington Post* (May 10) that the two environmental specialists would have testified that they had repeatedly warned their Army superiors that an environmental assessment was needed and that important documents had

been suppressed.

The *Post* also reported that, according to three unreleased reports prepared for the Army by the BDM Corp. of McLean, VA, EMPs can knock out the electronic landing systems on commercial airliners and can cause human health problems.

Under the agreement, the DOD will pay Rifkin's group more than $31,000 in attorneys' fees.

In other EMP-related news:

• Patricia Axelrod is expected to appeal an April 29 decision dismissing her contention that EMFs from EMPRESS II pose a detonation risk to ordnance. Axelrod had earlier filed a separate suit seeking the preparation of an EIS on hazards of electromagnetic radiation to ordnance or "HERO" from all types of EMFs (see *MWN*, September/October 1987). That suit is pending.

• The Navy has released the final EIS for EMPRESS II. For more information, contact: Ronald Dudley, Installations Planning Division, Naval Facilities Engineering Command, Norfolk, VA 23511, (804) 445-2306.

• Under the DOD's fiscal year (FY) 1988 appropriations, the Navy is barred from using EMPRESS II in the Chesapeake Bay until the Secretary of Defense certifies that its use is "essential to the national security" and that its economic, environmental and social costs in the bay are "far less" than elsewhere. On May 10, the U.S. Senate approved an amendment to the DOD's FY89 budget which would extend this prohibition. A similar bill will be introduced in the House.

Broadcasters' Compliance Costs for RF Rules Revised

The Tax Reform Act of 1986 has increased the broadcast industry's potential costs for compliance with a radiofrequency (RF) exposure standard by 30-40%, according to an analysis for the Environmental Protection Agency (EPA).

The revised cost for television and FM radio broadcasters to meet a 100 $\mu W/cm^2$ standard and for AM stations to meet an 87 V/m limit would be $47.6 million. With standards of 200 $\mu W/cm^2$ and 275 V/m, the cost would be $30.9 million, while with limits of 1,000 $\mu W/cm^2$ and 614 V/m (the American National Standards Institute guidelines), the cost would be only $16.1 million. The three sets of options were proposed by the EPA in 1986, together with a fourth option – not to regulate RF radiation (see *MWN*, July/August 1986).

The revised estimates were requested by the National Association of Broadcasters at a 1986 hearing on the EPA options. The analysis was done for the EPA by Jack Faucett Associates of Bethesda, MD. The original analysis was performed by the Lawrence Livermore National Laboratory (see *MWN*, September/October 1985).

The two principal reasons for the increased costs are the tax law's devaluation of corporate business deductions due to the reduced corporate tax rates and the elimination of the investment tax credit, according to the Faucett report.

For more information on *An Estimate of the Potential Costs of Guidelines Limiting Public Exposure to RF Radiation from Broadcast Sources: Amendments Following the Tax Reform Act of 1986*, contact: EPA's Norbert Hankin, Office of Radiation Programs (ANR-461), 401 M Street, SW, Washington, DC 20460, (202) 475-9630.

Ailing FAA Technician Fights for Workers' Compensation

Eugene Shrouf, a former Federal Aviation Administration (FAA) technician who alleges that prolonged exposure to microwave (MW) radiation is responsible for his brain tumors and endocrine problems, is fighting a drawn-out battle with the Department of Labor (DOL) for workers' compensation.

In August 1986, the DOL's Office of Workers' Compensation Programs ruled that Shrouf had failed to prove that microwave exposure caused his health problems. Shrouf, now 66 years old, is seeking a review of the decision based on more recent data.

In a February 17 letter of support for Shrouf's claim, Dr. Samuel Milham, an epidemiologist at the Washington State Department of Social and Health Services, states that, "It is my opinion that [Shrouf's] present status is a result of exposure to [VHF, UHF and MW] radiation received while in the employ of the FAA." Milham cites the long-term exposure study at the University of Washington in Seattle as an indication that endocrine tumors are associated with long-term exposure to microwave radiation, and he refers to his own research showing that brain tumors are "more common than expected in the electrical trades."

For more than a decade, Shrouf and two other technicians, Andrew Loesch and Ervin Kreischer, worked together at an FAA facility in Albuquerque, NM, repairing, adjusting and maintaining VOR, TACAN and ILS equipment (see *MWN*, May 1985). According to Shrouf, all three came very close to radiating antennas, often taking readings from less than 12 inches away. (TACAN stands for "tactical air navigation" and operates at 0.962-1.024 GHz and 1.151-1.213 GHz. VOR and ILS are short for "very high frequency omni-range" and "instrument landing system," respectively.)

Loesch and Kreischer also suffered from cancer and endocrine problems. Like Shrouf, they too were denied workers' compensation. Both are now dead.

Kreischer was diagnosed as having prostate cancer. After surgery and radiation therapy, he developed cardiac problems and ultimately bone cancer. Loesch had brain tumors, among many other ailments.

Of the three, Shrouf considers himself to be "the lucky one." After surgery to remove a benign brain tumor – a pituitary adenoma – he now suffers from hypothyroidism and adrenal damage. He requires daily doses of steroids.

During his 14 years as an FAA technician, Shrouf estimates that he was exposed to over 25,000 hours of microwave and other types of radiation. He told *Microwave News* that neither he nor his coworkers were ever informed about potential radiation hazards. In 1983, however, after the three had retired, the FAA issued a "safety memo" which warned personnel to "avoid direct contact with the TACAN radome and limit the duration of maintenance work in close proximity to the antenna while the TACAN is transmitting." Shrouf insists that although the agency claims to have issued previous safety memos, this was the first warning he had ever received and that the FAA has failed to come up with any indication that such memos ever existed.

Dr. Ira Kaplan, a board certified internist who reviewed Shrouf's claim for the FAA, states "unequivocally" that Shrouf's condition was not related to his employment – contrary to a report by a family practitioner, Dr. Karl Robinson, who told the FAA that he was "convinced" that Shrouf's tumor was caused by occupational radiation exposure.

In the 1970s, two TACAN technicians working at the Naval Air Rework Station at Quonset Point, RI, developed pancreatic cancer and other endocrine disorders. One of the men, Robert Engell, filed a $4.5 million lawsuit against a number of electronics companies. The suit was later settled out of court (see *MWN*, January/February 1983).

Cape Cod Cancer Study Will Include EMFs

The Boston University (BU) School of Public Health will study the possible association between environmental factors – including high- and low-frequency radiation from PAVE PAWS radar and power lines – and elevated cancer rates on Cape Cod, under a $500,000, two-year grant from the state of Massachusetts.

The announcement of the study closely follows the April 21 release of an exploratory survey, *Analysis of Lung Cancer Mortality in Females and Leukemia Mortality in Males and Females for the Towns of Barnstable, Bourne, Falmouth, Mashpee, and Sandwich, 1969-1985*, by the Massachusetts Department of Public Health, which documents a higher death rate among long-term (15 years or more) Upper Cape residents and a possible link to environmental exposures. BU's "Phase II" study is intended as a comprehensive follow-up.

Dr. Ann Aschengrau of the Department of Epidemiology and Biostatistics at BU's School of Public Health, one of the study's principal investigators, told *Microwave News* that her group will look at water and air pollution, radiofrequency radiation from the U.S. Air Force's PAVE PAWS radar and extremely low frequency (ELF) fields from power lines. The study, which will include a 25-year residential history of 3,000 local inhabitants, will also consider data on "confounders," such as diet and alcohol and tobacco use.

FROM THE FIELD

Henhouse PMF Project: Communiqué from Madrid

Reprinted below is a communiqué released following a meeting of the Henhouse Project researchers, who are investigating the effects of weak pulsed magnetic fields (PMFs). They met in Madrid, Spain, April 25-29 (see MWN, *March/April 1988). In addition to Dr. Jocelyne Leal and her collaborators – Drs. L. Chacon, K. Shamsaifar, M. Trillo and A. Ubeda – at the Ramon y Cajal Hospital in Madrid, those in attendance included: Dr. Ezra Berman of the Environmental Protection Agency (EPA), Research Triangle Park, NC; Dr. Barbara Koch of the University of North Carolina, Chapel Hill; Dr. Alexander Martin of the University of Western Ontario, London, Canada; Dr. Kjell Hansson Mild of the National Institute of Occupational Health, Umea, Sweden; Jack Monahan of the Food and Drug Administration, Rockville, MD; Dr. Tom Rozzell of the National Research Council, Washington, DC (and formerly with the Office of Naval Research); and Richard Tell of Richard Tell Associates, Inc., Las Vegas, NV.*

A group of investigators from six laboratories in Canada, Spain, Sweden and the United States met in Madrid from April 25-29 (sponsored by the Spanish Ministry of Health) to discuss the results of their recently completed investigations. The purpose of this set of experiments known as Project Henhouse was to examine the effects of weak low frequency, pulsed magnetic fields (PMFs) on early embryonic development of the fertile chicken egg. The project was initiated in 1984 under the auspices of the U.S. Office of Naval Research to further examine the reports from the laboratory of Dr. Leal at the Ramon y Cajal Hospital in Madrid that exposure to pulsed magnetic fields could cause developmental abnormalities.

Each of the six laboratories participating in Project Henhouse was equipped with identical exposure and incubation equipment that had been specially designed and subsequently calibrated by the U.S. Environmental Protection Agency for these studies. Each laboratory then conducted a series of replicate exposures of 20 eggs (10 treated/10 control) for the first 48 hours of incubation. The treated eggs were exposed to a PMF having a repetition frequency of 100 pulses per second. Following the 48-hour exposure, all embryos were evaluated for maturity and morphology.

Two of the six laboratories demonstrated a significant increase in the incidence of developmental abnormalities. Three of the remaining four laboratories had more abnormal embryos in the treated than in the sham group. When the data from all laboratories were combined, a significant increase in developmental abnormalities from

exposure to low-level PMFs was found. While every attempt was made to have identical conditions in each laboratory, some variables could not be controlled, and differences in the results between laboratories were observed. On the basis of all their results, the investigators in Project Henhouse have concluded that exposure to weak PMFs, under certain conditions as yet undefined, can cause significant developmental abnormalities in the chicken embryo.

Using different PMFs, previous studies have reported similar findings, but several other studies have not observed this effect. There is now substantial evidence that the effect is real, but may be influenced by uncontrolled variables in addition to the PMF.

It is important to note that extrapolation of the results of Project Henhouse beyond the chicken embryo and the exposure parameters of this study is very difficult at the present time. However, there are reports about biological effects of exposure to weak alternating magnetic fields with various waveforms, thus indicating that it might not be the pulse form as such that is the most important parameter. Other parameters such as intensity, pulse repetition frequency, fluctuations in intensity, or other variables may be more significant for production of these biological effects. Therefore, dose-response relationships which are normally used for extrapolation cannot be used until the critical parameters are known. The question the scientific community should now focus on is not whether weak electromagnetic fields affect development but rather, how they affect it. On the basis of the findings of this and other studies, further research is warranted.

During the meeting in Madrid, a draft manuscript of Project Henhouse was prepared and will be submitted for publication in the near future. The results of these studies will be presented at a scientific meeting in June. In addition, preliminary protocols for future work of the group were developed. These protocols will be finalized over the coming months and submitted to potential sponsors for funding.

UPDATES

BIOLOGICAL EFFECTS

EPA's RF/MW Report... Dr. Joe Elder, who, with Dr. Dan Cahill, edited the 1984 EPA report on the *Biological Effects of Radiofrequency Radiation*, has prepared an update based on the literature available through May 1987. The 1984 report was designed to be the basis for the agency's long-delayed RF/MW radiation guidance. Elder does not cover cancer in this new review. The 1987 conclusion differs little from the earlier one: the threshold for bioeffects is about 1 W/Kg (see *MWN*, January/February and December 1984). Here is how Elder sums it all up: "Exposure to RF radiation causes biological effects at SARs above and below 1 W/Kg; some of the effects which occur at about 1 W/Kg may be significant under certain environmental conditions. The biological significance of the effects which occur at SARs below 1 W/Kg, including those which occur at specific temperatures different from the physiological temperature range, specific frequencies or at specific amplitude-modulation conditions, is not established." For a copy of *A Reassessment of the Biological Effects of RF Radiation: Non-Cancer Effects*, contact: Dr. Joe Elder, MD-74, Health Effects Research Lab, EPA, Research Triangle Park, NC 27711.

Sunlight Activates HIV...A number of chemicals and viral agents can enhance the gene expression of HIV, the virus responsible for AIDS. Now, an international group of researchers has found that UV and even ordinary sunlight can also enhance HIV activity. In the May 5 issue of *Nature* (pp.78-81), the team goes further, concluding that their work "raises the possibility that the virus can be activated by direct sunlight."

COMMUNICATIONS

FM and TV Radiation...A researcher at the Finnish Center for Radiation and Nuclear Safety in Helsinki has devised a simple model for predicting the power density near television and FM radio transmitters and has verified it with measurements. Dr. Kari Jokela estimates that the power density is typically less than 1 mW/cm^2 at about 40 meters from 10 kW (input power) UHF-TV antennas, 30 meters from 20 kW FM radio antennas and 15 meters from 4 kW VHF-TV antennas. For details, see Jokela's paper in the May 1988 issue of *Health Physics*.

COMPATIBILITY & INTERFERENCE

Ambulance Strobe EMI... An ambulance's flashing light can interfere with the operation of an onboard cardiac-monitor, according to a letter in *The New England Journal of Medicine* (March 3, 1988). It seems that on the way to the hospital, a 65-year-old woman with heart palpitations began to show abnormal "flutters," although her vital signs were unaffected. The paramedic team noted that the monitor showed an abnormal rhythm only when the ambulance's Opticon strobe, which can turn traffic lights from red to green, was turned on and the woman's hands were touching the metal railings of the patient cart. They soon found that the flutters occurred at the same rate at which the strobe flashed, 9-11 beats per second, as opposed to the five-per-second rate for a typical atrial flutter. The explanation that evolved is that the Opticon induces an EMF large enough to be picked up by the leads of the monitor; alternatively, the cardiac-monitor can pick up the signal from the paramedic vehicle through the cart. The local service department eliminated the EMI by insulating the patient cart.

TV Interference... The FCC's Harry Wong has developed a model to calculate EMI to TV channels 4 and 5 from other communications sources – for instance, private radio and land mobile transmitters. A copy of Wong's report, *Potential Interference from Operational Fixed Stations in the 72-76 MHz Band to Television Channels 4 and 5*, Office of Engineering and Technology Bulletin No.67, is available from

International Transcription Services, 2100 M Street, NW, Washington, DC 20037, (202) 857-3800. For further information, contact Wong at (202) 653-8159.

Protecting Ms. Liberty... Even though she is over 100 years old and has been struck by lightning thousands of times, the Statue of Liberty has suffered no significant damage. She has been protected by the natural conductivity of her copper "skin" and by the efficiency of her original protection system. During her recent restoration, JLN Violette & Associates of McLean, VA, assessed the system and found that, for the most part, only minor repairs and alterations were necessary. In the March/April 1988 *EMC Technology & Interference Control News*, a controlled circulation magazine based in Gainesville, VA, two members of the firm describe the statue's grounding system and the minor improvements they recommended, which included installing copper lightning rods on her torch.

Canceling EMI... Researchers at the California Institute of Technology in Pasadena, CA, have devised a way to measure emissions from a device, even in the presence of a relatively strong interfering signal. The technique uses two receiving antennas to set up destructive interference and thereby cancel out the corrupting EMI. NASA's Jet Propulsion Lab (JPL) sponsored the work and has applied for a patent. For more information, contact: Norman Chalfin, Manager, Technology Utilization, JPL, 4800 Oak Grove Drive, Pasadena, CA 91109. Ask for a copy of JPL Invention Report NPO-17132, dated April 1988.

MEETINGS

Gordon Conference... With all the new developments on bioeffects and mechanisms over the last two years, this summer's *Gordon Research Conference on Bioelectrochemistry* promises some lively discussions. The meeting is always very informal: everything said is off-the-record and no proceedings are published. Sessions are held in the mornings and in the evenings, leaving the afternoons free for recreation or whatever seems appropriate at the time. Dr. Betty Sisken, who is chairing the conference, has assembled an international lineup of speakers. The meeting will be held at Plymouth State College in New Hampshire, August 15-19. For more information, contact: Dr. Betty Sisken, Dept. of Anatomy, University of Kentucky, Lexington, KY 40506, (606) 257-5796.

MILITARY SYSTEMS

Burning a Hole in the Atmosphere... The use of high-power EM radiation in the upper atmosphere is raising concerns over its potential environmental impact. On August 11, 1987, Dr. Bernard Eastlund of Spring, TX, was granted a patent (No.4,686,605) for a way of heating charged particles in the earth's atmosphere with radiation in the 20-1800 kHz frequency band, which he says could result in the "total disruption of communications over a large portion of the earth." Alternatively, the system could be used to modify weather. Eastlund points out that his system "would have significant military implications, particularly as a barrier to, or confusing factor for, hostile missiles or airplanes." The patent has been assigned to APTI, Inc., a subsidiary of Atlantic Richfield. Writing in the April issue of *Physics and Society*, Dr. Richard Williams, a physicist based in Princeton, NJ, warns that Eastlund's invention "might become a serious threat to the earth's atmosphere" and that it is not known how Eastlund's ideas might be applied because two other patents concerning this same invention are classified secret. In his unclassified patent, Eastlund notes that a phased array antenna would be ideal for generating the desired signal and that the North Slope of Alaska would be a good place to test the weapon. Although a lot of energy – 10^9-10^{11} watts – would be needed, the capability is within the state-of-the-art. Indeed, Eastlund told Williams that "a secret project is already underway to study and implement the invention."

OVENS

Is It Dinner Yet?...3M is marketing a product which, it claims, takes the "guesswork" out of microwave cooking. The "MonitorMark Microwave Doneness Indicator" is a time- and temperature-sensitive strip which turns blue when microwaved food is "optimally" ready to serve. Each strip is customized to a given food product, taking into account variations in oven size, cooking instructions and storage temperature – all of which can affect cooking time. Originally developed to help preserve and transport temperature-sensitive vaccines, the 3M strip is currently on Armour frozen dinners. 3M foresees a huge market for the strip – the company estimates that retail sales of "microwave-able" foods already top $21 billion a year. The company also anticipates further uses for the MonitorMark, including monitoring the temperature of products maintained in refrigerated storage, as in a supermarket or at a deli counter. For more information, contact: Colleen Foster, Packaging Systems Division, Bldg. 220-8W-01, 3M Center, St. Paul, MN 55144.

Beyond Food... Chemists at Canada's Laurentian University are using a microwave oven to speed up chemical reactions – by a factor of up to 1,000. They found that some mixtures exploded on irradiation and so they are now putting their reagents in Teflon bottles, which are transparent to the microwaves. The team's experiments are described in the May 19 *New Scientist*....Once you have finished warming up your chemicals, you can put your microwave oven to a more frivolous use: tie-dying t-shirts and scarves. With Micro Dye, Dylon International Ltd. of London, U.K., hopes to corner the market for the do-it-yourself Beau Brummell set. There are eight different colors and the whole process takes only four minutes. Stahlwood Mfg. Co. of Maspeth, NY, is the U.S. distributor.

PEOPLE

The Electromagnetic Energy Policy Alliance (EEPA) has a new president, Dr. **Jay Brandinger** of the David Sarnoff Research Center – formerly part of RCA and now a subsidiary of SRI International. He replaces **Barry Umansky** of the National Association of Broadcasters. Other EEPA officers include **George Wilkening,** a vice president of AT&T Bell Labs, and **Donald Walker,** a vice president of Motorola. **James Carter, Jr.** of Rockwell International is the treasurer and Dr. **John Osepchuk** of Raytheon is the secretary....**Paul Wagner** has transferred from EPA's Office of Radiation Programs in Las Vegas, NV, to the agency's regional office in Atlanta, GA. Wagner had taken over from **Ric Tell,** who left EPA to open his own consulting firm. **Ed Mantiply** is now the only remaining staffer working in Las Vegas on non-ionizing radiation.

STANDARDS

Finnish NIER Rules... On December 4, 1987, the Finnish Ministry of Health and Social Affairs issued a decree regulating products and installations that emit non-ionizing radiation – that is, any electromagnetic field with a frequency of less than 3,000 GHz. The Finnish Center for Radiation Safety is charged with setting safety standards. Among the devices covered by the new rules are UV lamps used for skin treatment, diathermy and hyperthermia equipment, certain types of lasers and other radiation devices designed to be used in the home. Radio and television transmitters and radars, with an average power of less than 1 kW (or a peak pulse of 100 kW), must also be inspected before being put into service. The rules became effective on January 1, 1988. An English translation of the Finnish regulations is available from: JoAnne Overman, Office of Standards Code and Information, Administration Bldg., Room A629, NBS, Gaithersburg, MD 20899, (301) 975-4037. Ask for regulation TBT/Notif.88.36.

IRPA Updates Laser Exposure Limits...IRPA's International Non-Ionizing Radiation Committee has issued some "minor" updates to its 1985 guidelines for human exposures to laser radiation. The changes appear in the May 1988 issue of *Health Physics*, pp.573-574.

TECHNOLOGY

Competing with Japan... Fusion Systems Corp., a small Rockville, MD, high-technology company, is battling with the Japanese conglomerate Mitsubishi over its patented microwave lamp system. In 1977, Fusion sold Mitsubishi Electric its system, which employs MWs to drive high-power UV lamps and is used in the production of semiconductor chips, optical fibers and many other items. Soon after, according to Fusion, Mitsubishi reverse-engineered the system and began filing numerous patents – nearly 200 over the next ten years – in an effort to overpower its smaller U.S. competitor. Fusion says its repeated attempts at a negotiated settlement have been spurned by Mitsubishi, which demanded a worldwide, royalty-free license for all of Fusion's technology, plus substantial cash and royalty payments. Fusion, which believes that its case is not unique, claims to seek only "the right to continue marketing its own technology." On April 26, PBS ran a "Frontline" documentary which included a segment on the Fusion-Mitsubishi dispute.

VDTs

Radiation Shield... An independent Canadian researcher plans to market a device to contain radiation emissions from any standard VDT. The Ancile Protective Screen and Shroud System – essentially a Faraday cage which can hold a VDT – is designed to reduce ELF and VLF emissions and to control the buildup of electrostatic charges. Al Orr, the shield's developer, has already built ten prototypes of the unit and is now seeking venture capital for its production. He anticipates that the device will cost $400-450 (U.S.). For more information, contact: Al Orr, Ancile Radiation Protective Systems, 3024 Countryside Drive, R.R.#4, Brampton, Ontario L6T 3S1, Canada, (416) 840-1859.

County Legislation... On May 10, legislators in Suffolk County on NY's Long Island approved a bill mandating eye care, ergonomic standards and rest breaks for VDT workers. The bill, introduced by Suffolk County Legislator John Foley, applies to businesses using 20 or more VDTs and to operators working at terminals for more than 26 hours a week. If signed into law by County Executive Patrick Halpin, beginning in January 1990, employers will have to pay 80% of the cost of employee eye exams and glasses and provide 15-minute rest breaks every three hours. In addition, the legislature will have to set up a five-member review committee to issue biennial reports on ergonomic and technological developments. Halpin, who has favored VDT rules in the past, must decide by June 9. Last year, a similar bill was vetoed by the previous county executive. Under a compromise, the legislators passed a bill which applies only to county workers.

ETC...

EM Energy News... Dr. Geoffrey Voss, who recently stepped down as the editor of IMPI's *Journal of Microwave Power*, has started his own publication, *Electromagnetic Energy Reviews*. In an editorial in the first issue, dated May 1988, Voss and coeditor Paul Fisher announce that, "Our objective is to provide you with current information, educational material and ideas in the applications of electromagnetic energy." The newsletter will address non-communication, non-military topics in the frequency range of 1 MHz to 1 PHz (10^{15} Hz). Subscriptions are $32.00 (U.S.), $40.00 (Canada) and £18 (U.K., by air mail). Contact: Voss Associates Engineering, Suite 401, 1011 Fort Street, Victoria, BC V8V 3K5, Canada, (604) 384-1021.

Dr. Irving Selikoff, the editor-in-chief of the peer-reviewed journal and a world-renowned specialist in occupational health, called the Goldhaber findings "worrisome." He said that, "There have been warnings that we now live in a world flooded with non-ionizing radiation, the long-term effects of which are largely unstudied. Some of the most serious potential effects are reproductive hazards; the last ten years have seen hints that these may occur with VDT radiation." Selikoff is at the Mount Sinai School of Medicine in New York City and has been seeking funds for a VDT-pregnancy study (see *MWN*, June 1985 and May/June and September/October 1987).

Dr. Michele Marcus, also at Mount Sinai, who is collaborating with Selikoff, said that the Kaiser study is "important" and that it "makes it clear that this issue needs further investigation."

Over the last few years a number of other epidemiological studies have suggested a link between VDT work and adverse pregnancy outcomes. In each case, the results were not clear-cut and the authors dismissed the pregnancy risk:

- Sweden's Drs. Anders Ericson of the National Board of Health and Social Welfare and Bengt Kallen of the University of Lund uncovered a statistically significant, dose-dependent association between VDT work and birth defects, but they cautioned that they were unable to separate VDT exposure from other variables, such as smoking and stress (see *MWN*, July/August 1986).
- Dr. Peter Westerholm of the Swedish Trade Union Confederation reported an increase in congenital malformations – especially of the heart – among the offspring of some VDT operators, but the trend did not follow a dose-response relationship (see *MWN*, July/August 1986).
- Dr. Kari Kurppa of the Finnish Institute of Occupational Health in Helsinki also reported an increase in cardiovascular abnormalities among the children of part-time VDT workers (see *MWN*, January/February 1985 and March/April 1986).
- Dr. Alison MacDonald of the Institut de Recherche en Santé et en Sécurité du Travail du Québec in Montreal, Canada, found an increased risk of spontaneous abortions among part-time – but not full-time – operators. She attributed the finding to recall bias (see *MWN*, July/August 1986).
- Drs. Bill Butler and Kelley Brix, formerly of the University of Michigan in Ann Arbor, found a slight but not significant number of spontaneous abortions among women who used VDTs more than 20 hours a week (see *MWN*, September/October 1986).

After reviewing most of these studies, the Kaiser team concludes that even though the increased risks of adverse pregnancy outcomes were small, "consistent evidence across studies provides some basis to suspect that an excess risk could be real."

Goldhaber and coworkers' survey of 1,583 pregnant women indicates that the risk for both early (less than 12 weeks) and late (12 weeks or more) miscarriages increased approximately 80% for all women who worked on VDTs more than 20 hours a week, as compared to women who did similar work without VDTs. There was a 100% increase in miscarriages when the VDT operators were compared to non-working women. There was no statistically significant increase in risk for women who used VDTs less than 20 hours a week.

For administrative support and clerical workers, a subgroup of the study population, the miscarriage risk was 240% that of the rate for non-exposed workers in the same category. This finding is statistically significant.

The number of birth defects was too small to support a statistically significant link at any level of exposure, although the Kaiser team did find a 40% increase for both moderate (5-20 hours a week) and heavy (more than 20 hours a week) use.

Goldhaber and coworkers warn that their VDT-miscarriage link may be exaggerated by recall bias – the overestimation by women with adverse pregnancy outcomes of their time spent at terminals. Nor can they fully discount ergonomic factors or job stress. Nevertheless, the researchers are unable to eliminate the possibility that the VDTs were responsible for the increased risk.

Study History

The Kaiser study was originally designed to investigate the possible reproductive impact of malathion, a pesticide which was sprayed in California from 1981 to 1982 to combat medflies. In the fall of 1982, prompted by a rash of reported clusters of adverse pregnancy outcomes among VDT operators, the federal National Institute of Occupational Safety and Health (NIOSH) asked Kaiser to include some questions on VDT use in the pesticide study. After the collaboration was announced, negotiations with Kaiser broke down (see *MWN*, November 1982 and June and July/August 1983).

NIOSH finally launched a separate VDT epidemiological study, which is scheduled to be completed this fall (see *MWN*, May and December 1984, January/February 1985, January/February 1986 and September/October 1987). Meanwhile, Kaiser went ahead and included VDT questions in its malathion study.

The Kaiser epidemiological VDT study is the first seriously to consider low frequency magnetic fields. Because the highest electromagnetic fields are at the sides and at the rear of the sets – not at the front – the number of hours at a terminal may not be a reliable index of exposure and may indeed underestimate an operator's time exposed to the field. The Kaiser researchers acknowledge this and note, "Exposure can be dependent on office seating arrangements and coworkers' use of the machines. This fact, however, would only weaken our ability to detect any effect related to non-ionizing radiation." That is to say, if there is a link between problem pregnancies and VDT electromagnetic fields, then the risk is greater than suggested in this study.

In light of their findings, the Kaiser team emphasizes the need for further investigations and calls for large-scale studies of working women to provide "objective measures of VDT exposure, ergonomic factors and job stress during early pregnancy." Indeed, Mount Sinai's Selikoff stresses that, "There are few research areas that deserve more urgent priority."

fields. Such a synergistic reaction between ELF fields and a carcinogen is in itself a major finding. But for those in search of a mechanism to explain ELF effects, Leung's results – uncertain though they may be – relating melatonin and, therefore, the pineal to the promotion of cancer may be equally important.

The role of the pineal in the development – or, more precisely, in the inhibition – of hormone-dependent cancers has been well established over the last few years. In September 1987, at an *International Workshop on the Pineal Gland and Cancer* in Tübingen, West Germany, scientists reviewed the latest research; "The workshop's take-home lessons were that melatonin can inhibit tumor formation and can have a significant impact on the immune system," Wilson told *Microwave News*.

The pineal synthesizes serotonin, a neurotransmitter, which is metabolized into melatonin, which in turn is secreted into the bloodstream and the cerebrospinal fluid (CSF). Daylight suppresses melatonin production, as do stress, alcohol and EMFs. Lower levels of melatonin, the argument goes, result in an elevated risk of cancer.

EMFs also alter the balance of other neurochemicals. In 1985, Dr. Richard Seegal of the New York State Department of Health reported that 60 Hz electric and magnetic fields can lower the levels of 5-hydroxyindoleactic acid (5-HIAA) in the CSF of primates (see *MWN*, November/December 1985). Reduced concentrations of 5-HIAA, which is a metabolite of serotonin, have been associated with depression and suicidal behavior.

Interestingly, two papers, published in 1979 and 1981, by Drs. Stephen Perry, Robert Becker, Andrew Marino and Maria Reichmanis identified an association between living near 50 Hz power lines and suicide (see *MWN*, December 1981). More recently, Perry extended his work to show that people exposed to ELF fields in high-rise apartments also are more likely to suffer from depression (see *MWN*, November/December 1987).

In the 1970s, reports from the Soviet Union indicated that workers exposed to power line fields had higher than expected rates of fatigue, irritability and headaches.

Earlier this year, a team headed by Dr. David Dowson of the U.K.'s Centre for Complementary Medicine in Southampton reported new support for the link between power line exposures and depression and headaches.

There are still many loose connections in this line of argument. Seegal himself is skeptical that his work supports a link between ELF fields and suicides. "It's a natural connection, but there are enough warning signs that the connection is tenuous at best," he said in a telephone interview from his lab in Albany, NY.

On the other hand, Perry told *Microwave News* that he thinks the link is credible and must be studied further. For his part, Becker said that he is confident that there is a relationship between depressive states and chronic exposure to ELF fields.

EMFs can shift circadian rhythms. This effect appears to be analogous to the now well-established "seasonal affective disorders" (known as "SAD"), which are caused by shifts in pineal rhythms and which can, to a certain extent, be remedied by daily exposure to bright light.

Leung's Experiments

Leung and coworkers ran two similar experiments: Rats exposed to 60 Hz, 40 kV/m electric fields were injected with 7,12-dimethylbenz(a)anthracene (DMBA), a known carcinogen. Rats exposed to both ELF fields and DMBA had more tumors per tumor-bearing animal than those receiving only DMBA. In each case, however, the increase was not statistically significant and last November, Leung reported them as negative. But Leung told *Microwave News* that, when the data from both experiments were later combined, the increase *was* significant. Battelle's research on electric fields and the pineal has been supported by the Department of Energy.

Lee Rosen of W/L Associates in Frederick, MD, agreed that Leung's experiment points to the involvement of the pineal. "This may be the key to understanding how EMFs affect the body," he told *Microwave News*. "We may now have a defined, reproducible biological endpoint for monitoring the development of cancer as well as other effects."

Battelle's Dr. Richard Stevens goes even further, stating that EMF impairment of the pineal may be implicated in the observed increase in breast cancer among women in industrialized countries (see *MWN*, January/February 1987). At the Tübingen workshop, he described how alterations in melatonin rhythm by EMFs and light – among other factors – may provide a framework for interpreting mechanisms of action for hormone-related cancers. Stevens is seeking funds for an epidemiological study of breast cancer and its possible relation to electric power use.

Rosen favors extending current studies by using magnetic, rather than only electric, fields. In addition, he would like to see experiments with longer exposure periods to determine long-term impacts, if any.

The debate will continue July 25-27 in Hong Kong at a symposium on *Melatonin and the Pineal Gland*, which is an offshoot of the *8th International Congress of Endocrinology*.

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