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A Report on Non-Ionizing Radiation

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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.

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 $\mu\text{W}/\text{cm}^2$ 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 $\mu\text{W}/\text{cm}^2$ 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/cm^2 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."

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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 about 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 Haismaier, 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 (EPPA) 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 $\mu\text{V}/\text{m}$ at 300 meters; for 450 kHz-1.705 MHz: 24/F $\mu\text{V}/\text{m}$ at 30 meters (where F is in MHz); and for 1.705-30 MHz: 15 $\mu\text{V}/\text{m}$ 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 $\mu\text{V}/\text{m}$ 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 $\mu\text{V}/\text{m}$ 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,

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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 of-

fered 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 Elektropathologie, 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 Ave., 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 $32.7 \pm 0.7^\circ\text{C}$ to $33.1 \pm 0.6^\circ\text{C}$. 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 $\mu\text{A}/\text{cm}^2$ 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 $\mu\text{A}/\text{cm}^2$ 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.

MICROWAVE NEWS is published bimonthly • ISSN 0275-6595 • PO Box 1799, Grand Central Station, New York, NY 10163 • (212) 517-2800 • Editor and Publisher: Louis Slesin, Ph.D.; Senior Editor: Mark Pinsky; Associate Editor: Amy Rosenberg • Subscriptions: \$200 per year (\$235 overseas); single copies: \$40.00 • Copyright © 1986 by Louis Slesin • Reproduction in any form is forbidden without written permission. • We invite contributions to *From the Field*, our column featuring news and opinions from the non-ionizing radiation community. Letters from readers are also welcome.

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 Insti-

tute, 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 Electrobiolgy, 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).

BIOLOGICAL EFFECTS

Interest in UV-A Growing...A new FDA study indicates that UV-A radiation used by many commercial tanning 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 Tanning: 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 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 buffaloes 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/cm² recommended in safety guidelines. They also urge continued study of ocular 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 WYCG 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

UPDATES

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 Stranger 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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