PMFs Again Linked to Abnormal Pregnancies in Mice

New experimental data from Sweden support last year's finding that VDT-type radiation can upset fetal development in mice. Professor Gunnar Walinder and coworkers at the Swedish University of Agricultural Sciences in Uppsala have found a significant increase in fetal deaths and resorptions (fetal losses) among pregnant mice exposed to weak pulsed magnetic fields (PMFs), as compared to controls. The offspring of the exposed mice also had a higher incidence of malformations, though this finding is not statistically significant.

Last year, a group headed by Professor Bernhard Tribukait of the Department of Medical Radiobiology at the prestigious Karolinska Institute in Stockholm reported a significant increase in external malformations among mice exposed to VDT-type radiation (see *MWN*, March/April and May/June 1986).

The different results from the Uppsala and Karolinska studies may be due to the fact that the experiments used different strains of mice and different lengths of exposure: "They are not contradictory," Tribukait told *Microwave News* from his lab in Stockholm. "In general, it is the same effect." He added, "It is rather clear that the [PMF] effect is real."

Walinder, who heads the Radiobiological Oncology Unit at the agricultural university, agrees that the PMFs have an effect on the mice embryos, but does not think that the two sets of results are "consistent." In a telephone interview from Uppsala, Walinder hypothesized that the PMF exposures may cause increased fetal implantations and that these added fetuses are not surviving: "We are seeing a very early effect that makes animals more susceptible to implantation. Embryos that are normally rejected by the mice were accepted."

The Uppsala team exposed "CBA/s" mice to sawtooth PMFs for the first 19 days of pregnancy, after which the mice were killed; the Karolinska group exposed "C3H" mice for the first 14 days of pregnancy – these mice were killed on the 19th day.*

In the Uppsala study, there were increases in fetal death (2.3% v. 0.98%) and resorptions (10.67% v. 5.55%) among exposed mice, compared to unexposed controls, as well as a non-significant rise in malformations (see table on p.4). In the Karolinska study, there was a significant increase in serious malformations (1.9% v. 0.2%), but not in fetal deaths or resorptions.

"One possible explanation is that the malformed animals might have been killed during the longer exposure period," Tribukait suggested. Similarly, Dr. Kjell Hansson Mild of the Swedish National Board of Occupational Safety and Health in Umea reasoned, "The extra days of exposure may be causing the extra deaths." Most of the dead malformed fetuses in the Uppsala study had multiple malformations. In a related study, Mild and Dr. Ingrid Nordenson of Umea University have found genetic effects due to PMFs (see box on left).

The Uppsala mice study used the same type of radiation as that used in the Karolinska study: a 20 kHz sawtooth magnetic field with an intensity of 15 microtesla. The pulse had a rise time of 45 microseconds (μsec) and a fall time of 5 μsec. The shape and frequency of the pulses were designed to mimic emissions from video display terminals (VDTs).

In contrast to the active research program in Sweden, most U.S. experts have largely ignored the Karolinska results and continue to dismiss the risks associated with VDT radiation. No U.S. labs are attempting to repeat the mice experiment, largely due to the dearth of research funds.

At the Food and Drug Administration (FDA), scientists are watching the VDT studies and their "implications for public health," according to Roger Schneider, the associate director for science at the FDA's Center for Devices and Radiological Health in Rockville, MD. The FDA, which has the authority to regulate VDT radiation

PMFs: Chromosomal Changes

Dr. Ingrid Nordenson of the Department of Medical Genetics at Sweden's Umea University and Dr. Kjell Hansson Mild of the Swedish National Board of Occupational Safety and Health in Umea have found preliminary indications that VDT-type PMFs can cause genetic effects in exposed tissue samples.

In a poster paper presented at the Bioelectromagnetics Society meeting in Portland, OR, in June, Nordenson and Mild wrote that human amniotic cells exposed to 20 kHz sawtooth magnetic fields with intensities of up to 16 μT (peak-to-peak) for three days showed "significant increases in the frequency of aberrations in exposed cells compared to controls." Similar effects were seen among cells exposed to 30 μT sinusoidal 50 Hz fields for three days.

Nordenson and Mild noted that there was considerable inter-experimental variation in the results and that the "implications for human health were unclear." The work will expand: They plan to investigate PMF-induced oncogene expression and to study tissue samples from the Karolinska and Uppsala mice exposed to PMFs.

*The Uppsala and Karolinska teams used different systems to number the days in their experiments. Each lasted a total of 19 days. The Karolinska group called the first day, "day 0," and the last day, "day 18."

EFFECTS OF PMFs ON MICE: Uppsala Experimental Results

	PMF-Exposed	*Controls*
No. of female mice	245	173
No. of pregnant females	211 (86.1%)	154 (89.0%)
No. of non-pregnant females	34 (13.88%)	19 (10.98%)
No. of implantations	1,753	1,190
No. of resorptions	187 (10.67%)	66 (5.55%)
No. of live fetuses	1,530 (97.7%)	1,113 (99.0%)
No. of dead fetuses	36 (2.3%)	11 (0.98%)
Weight of live fetuses (gram)	0.957 ±0.003	0.947 ±0.003
Length of live fetuses (mm)	19.58 ±0.03	19.51 ±0.03
No. of Live Malformed Fetuses	16 (1.05%)	8 (0.72%)
No. of Malformations	21	13
No. of Dead Malformed Fetuses	5 (13.89%)	2 (18.18%)
No. of Malformations	13	2

emissions, has only a small research program on the biological effects of non-ionizing electromagnetic fields. Schneider noted that, "The FDA cannot afford to study VDTs separately from microwave ovens, diathermy or other types of electronic products."

Dr. Przemyslaw Czerski, also of the FDA, expressed a keen interest in the Swedish experiments and told *Microwave News* that reciprocal visits between agency scientists and the Swedish researchers are desirable and are being explored.

A number of scientists at the Environmental Protection Agency (EPA) are also monitoring the new developments, even though the agency is no longer doing any research on non-ionizing radiation. Dr. Ezra Berman, an EPA teratologist, commented that, "Although this [new] experiment shows early death while the previous one showed malformations, the interesting thing is they both show effects. That similarity should be examined further."

EPA's Dr. Carl Blackman is interested in exploring the possible effects of variations in the earth's magnetic field – these may provide clues to explain the differences in the observed experimental results, he suggested.

Berman is coordinating an international project to explore the effects of PMFs on chick embryos – a finding first reported by Dr. Jocelyne Leal of the Centro Ramon y Cajal Hospital in Madrid, Spain (see *MWN*, March 1983 and January/ February 1986). Preliminary results from the six participating labs – including Mild's and Leal's – are expected by the end of the year.

Walinder, Tribukait and Mild all agree that the PMF experiments must continue. "We cannot stop at this stage," Mild said. Walinder concurred, noting that he is "not convinced" that the effect is well understood. Plans for new studies are already underway. In his next experiment, Walinder will expose mice beginning on the fourth or fifth day of pregnancy to test his hypothesis concerning the effect on the frequency of implantation. He will also look for brain damage among the fetuses – which he called a more sensitive indicator of an effect.

Tribukait intends to run his next experiment at higher frequencies – at 40 kHz and, possibly, at 60 kHz. In addition, he would like to repeat his original study using the same strain of mice used by the Uppsala group. Walinder said that he is reluctant to use the Karolinska mice due to the risk of infection. On the other hand, Tribukait said that he is not worried about infections because the strains can be isolated from each other.

Tribukait is in the process of preparing a paper, which he intends to submit to the *International Journal of Radiation Biology*. Walinder wants to complete his next set of experiments before publishing his results.

The results of the Uppsala study were released in Sweden in June without fanfare; they have received little attention in the Swedish press.

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DNA MW Absorption Contested

Researchers at two independent labs in England and Sweden have failed to replicate experiments showing that aqueous solutions of DNA can absorb microwaves in the 1-10 GHz frequency band. Professor Edward Grant and coworkers at King's College, London, and Drs. B. Gestblom and E. Noreland of Uppsala University were unable to document any resonances or "any form of enhanced absorption." The new results appear in the July 9 issue of *Nature* (*328*, pp.145-146, 1987).

The absorption of microwaves by DNA was predicted by the theoretical work of Drs. Earl Prohofsky and Lonnie Van Zandt of Purdue University in West Lafayette, IN, and was first shown experimentally by Drs. Glenn Edwards and Chris Davis of the University of Maryland in College Park, Dr. Jeffrey Saffer of the National Cancer Institute in Bethesda, MD, and Dr. Mays Swicord of the Food and Drug Administration in Rockville, MD.

In a series of telephone interviews, U.S. researchers suggested two possible explanations for the lack of experimental agreement: variations in the DNA samples and/or differences in the sensitivity of the measurement techniques.

Edwards, who is now at Vanderbilt University in Nashville, TN, noted that, "Grant's paper failed to report the quality of the DNA sample or the ability of his technique to resolve small differences in dielectric properties."

Davis also remains confident that the microwave effect is real: "We have been trying to generate artifactual data to explain away our results, but we cannot." He said that producing the DNA samples is "not trivial," adding that the disagreement in experimental results may be due to "some subtleties in the samples."

Speaking from London, Grant stressed that his DNA "was prepared in exactly the same way" as the Maryland group's DNA. In fact, he said, a biochemist had gone to the U.S. to learn the technique.

The European researchers used time domain spectroscopy with pulsed radiation, while the Americans used a frequency domain technique with continuous wave microwaves. Grant argued that the two methods were identical and that the DNA samples "should not react differently" to the two types of radiation. As added proof, he pointed out that the Swedish group had also taken some frequency domain measurements and that these agreed with their time domain results. Grant said that these data were not included in the *Nature* paper, but would be cited in a future publication, now in preparation.

There will soon be added support for the negative results from Europe. Dr. Ken Foster of the University of Pennsylvania in Philadelphia – working with Dr. Michael Gealt of Drexel University, also in Philadelphia, and with Dr. Benjamin Epstein of the David Sarnoff Labs in Princeton, NJ – has failed to detect any DNA resonances, using the same measurement technique as Edwards did, but he did succeed in generating artifactual resonances. Foster told *Microwave News* that the magnitude of Edwards's resonances was much smaller than the errors specified by the manufacturer of the probe. "It's like trying to weigh an airmail letter with a bathroom scale," he said. These new results will appear in the September issue of the *Biophysical Journal*.

Edwards countered that it is easy to generate false resonances. "However, if the system is correctly calibrated," he said, "such artifacts will not occur."

For his part, Van Zandt maintains that the enhanced absorption is predicted by his theoretical work. "Maybe Glenn Edwards did not see it," he said, "but according to my calculations, there is a good chance he did."

The research is continuing on both sides of the Atlantic. Grant said that his next set of experiments will be run at lower frequencies – in the kHz range. These studies will be carried out in collaboration with Professor M. Mandel of the University of Leiden in Holland. Mandel, a physical chemist, is an expert on the dielectric properties of DNA. In addition, Grant said that he will run the experiment with frozen DNA.

In a month, Davis's group will start a new series of experiments using fresh DNA samples and a new measurement system. Edwards is also continuing his studies.

As the arguments about whether DNA in solution can absorb microwave energy continue, Saffer, who is now at the Jackson Laboratory in Bar Harbor, ME, is investigating what he calls the "biological significance" of these resonances under a recent $343,000 contract with the Office of Naval Research (ONR).

In preliminary experiments, Saffer has already shown that irradiation with 2-4 GHz microwaves can cause enhanced gene expression of plasmid DNA in *E. coli*. He admits that he is not certain that the radiation affects the DNA – it may change RNA translation – but he is sure that he is not observing a thermal effect because heat causes a decrease in expression.

Interestingly, much of the U.S. work on DNA absorption is being supported by the U.S. Navy, through ONR, while the English and Swedish work is being paid for by the U.S. Air Force.

See also L.L. Van Zandt, "Resonant Microwave Absorption by Dissolved DNA," *Physical Review Letters, 57*, pp.2085-2087, October 20, 1986; John Maddox, "Physicists About To Hi-Jack DNA?," *Nature, 324*, p.11, November 6, 1986; J.W. Powell et al. (including Edwards and F. Kremer), "Investigation of Far-Infrared Vibrational Modes in Polynucleotides," *Physical Review A, 35*, pp.3929-3939, May 1, 1987; Maxim Frank-Kamenetskii, "Physicists Retreat Again," *Nature, 328*, p.108, July 9, 1987; and *MWN*, May and November 1984, March and June 1985 and May/June 1987.

ANSI Too High? A Thermal View

Many people – citing non-thermal effects of radiofrequency and microwave (RF/MW) radiation – have argued that the widely used American National Standards Institute (ANSI) safety standard is too lax. Now, Dr. Christopher Gordon of the Environmental Protection Agency (EPA) makes the same case but only on the basis of thermal effects.

Writing in the most recent issue of *Bioelectromagnetics* (*8*, pp.111-118, 1987), Gordon argues that human health protection standards are incorrectly derived from animal data – by simply extrapolating to a larger weight. Gordon believes that RF/MW thermal effects should be scaled on the basis of whole-body surface area not whole-body mass, because the ability of mammals to dissipate heat decreases with increasing mass but is independent of surface area. According to his calculations, the ANSI standard of 0.4 W/Kg would translate into 0.06 W/Kg, an exposure level of approximately 150 $\mu W/cm^2$, if keyed to surface area rather than body mass.

Gordon's coworkers at the EPA's Health Effects Research Lab in Research Triangle Park, NC, have found that the threshold for thermal effects should be 1 W/Kg (see *MWN*, January/February 1984). In its draft criteria document on RF/MW radiation, the National Institute for Occupational Safety and Health (NIOSH) proposed a 2 W/Kg threshold (see *MWN*, July/August 1985). Using ANSI's safety factor of ten and scaling by surface area, the EPA and NIOSH standards would be 0.015 and 0.03 W/Kg, respectively, the equivalent of 38 and 75 $\mu W/cm^2$.

"I expect there will be a lot of discussion of Gordon's paper in the bioelectromagnetics community," predicts EPA's Dr. Joe Elder, who edited the agency's 1984 review of RF/MW bioeffects.

EPA's non-ionizing radiation research program has been closed down; Gordon is now doing research on toxic chemicals (see *MWN*, September/October 1986).

ELF NEWS

Long-Term ELF Behavioral Effect

Adult rats previously exposed to 60 Hz electric and magnetic fields in the womb and for the first few days of life responded to behavioral conditioning significantly more slowly than unexposed controls, according to Professor Kurt Salzinger of Polytechnic University in Brooklyn, NY. This is a "lasting effect that cannot be ignored," Salzinger told *Microwave News*.

Salzinger and coworkers exposed pregnant rats to 60 Hz, 30 kV/m electric and 1 G magnetic fields for their entire gestation period; the offspring were then exposed for the first eight days of life. When they were 90 days old, the male offspring were extensively trained on a random-interval reinforcement schedule and their responses were measured. The study was sponsored by the New York State Power Lines Project.

A key finding is that the rats' delayed responses were observed long after their exposure to ELF fields and after a good deal of conditioning. Indeed, in his report, Salzinger points out that "the effect might not have been found if we had been content to look only for immediate effects." The response rate of the exposed rats decreased up to 20%, as compared to controls.

In a telephone interview, Salzinger said that the effect was "robust" and "permanent," but that it was not yet clear whether the disability developed over time or after training. "We want to do more studies in which we train the rats earlier in order to separate out these two possibilities," he added.

Salzinger drew an analogy between the rats' behavioral defect and dyslexia, a reading disability. "You can only tell there is a problem when children start learning to read, and then you need a sensitive test," he said. Similarly, the rats' disability only became apparent when they were adults. Salzinger's final report notes that none of the exposed rats showed any differences in physical appearance, in activity level, in weight or in incidence of disease.

Salzinger and his collaborators – including Leo Birenbaum, Dr. Steven Freimark, Dr. Malcolm McCullough and Donald Phillips – also exposed rats to fields of 10 kV/m and 0.33 G and compared them to others exposed to 30 kV/m and 1 G. The less-exposed group showed less of an effect, but the difference was not statistically significant.

Like most of the other New York State researchers, Salzinger has been unable to raise any funds since the New York power line money ran out. "I've just about given up trying," he said. Salzinger, who is with the Department of Social Sciences at Polytechnic University, is a past president of the New York Academy of Sciences.

EPRI Funds Two New Occupational Studies

The Electric Power Research Institute (EPRI) has funded two new projects: (1) a feasibility study for a large-scale epidemiological survey of the risk of leukemia, particularly acute non-lymphocytic leukemia (ANLL), and primary brain cancer among utility workers exposed to electric and magnetic fields; and (2) an assessment of occupational exposures to power line fields.

In July, Dr. David Savitz of the University of North Carolina in Chapel Hill and J. Michael Silva of Enertech Consultants, Inc., in Sunnyvale, CA, began examining utilities for a suitable population for a case-control epidemiological study. By the time this first phase is completed in December 1988, Savitz and Silva will have both identified a utility to participate in the study and developed a tentative system to classify exposures by job title.

Savitz will also run a pilot mortality follow-up study of approximately 3,000 workers to ensure that enough cancer cases will be generated in the full-scale study. And Silva will measure both occupational and non-occupational electromagnetic exposures.

The proposed study will be designed to detect a relative risk of 2.0 for ANLL and primary brain cancers.

Dr. Joseph Bowman of the University of Southern California in Los Angeles is the principal investigator on the second study, which will test the validity of occupational titles as surrogates for actual measurement of electric and magnetic fields. Bowman is already collaborating with Dr. John Peters on an epidemiological study to test the Wertheimer-Leeper finding of a link between childhood leukemia and ELF fields (see *MWN*, November/ December 1986).

The exposure assessments will be based primarily on data from portable dosimeters. EPRI has specified the use of the dosimeter developed by IREQ, the research arm of Hydro-Quebec (see *MWN*, September/October 1986). Bowman will also collect data on other potential chemical and physical contaminants.

In a related development, Dr. Charles Rafferty, who has been filling in for Dr. Tom Rozzell at the Office of Naval Research, has joined EPRI as a project manager in the non-ionizing radiation sub-program.

NY Power Lines Project Report *(continued from p.1)*

The release of the New York panel report generated headlines in newspapers all over the world, focusing attention on the health risks associated with living next to power lines. The report has been in great demand; 600 copies have already been distributed and another 500 have been printed. A month after the report was issued, Dr. David Carpenter of the New York Department of Health, who served as the executive secretary of the panel, said that he was still getting five to ten calls a day from reporters. Congress plans to hold hearings in September (see box on p.1).

The panel avoided suggesting how wide right-of-ways should be next to power lines, but did recommend a "major research effort" to reduce exposures to magnetic fields associated with power delivery. Calling more research on the biological effects of electromagnetic fields "very important," the panel specifically suggested a search for thresholds for magnetic field effects and further extensive studies on the potential cancer link (see pp.8-10 for the full text of the panel's summary and recommendations).

In contrast to the current situation in which essentially all funds for ELF bioeffects research come from the Department of Energy (DOE) and from the Electric Power Research Institute (EPRI), the panel advocated that research be "administered by an agency, preferably federal, which is credible by virtue of being clearly independent of partisan influence." Carpenter told *Microwave News* that the intent of this recommendation was not to end DOE and EPRI support but to encourage others to join the research effort. Carpenter singled out the National Institutes of Health (NIH) as one agency that should participate.

The panel issued its report in July – six years after it was constituted to spend $5 million to investigate ELF health effects, eight years after Dr. Nancy Wertheimer and Ed Leeper published their epidemiological study first linking magnetic fields to childhood cancer and 14 years after applications were filed to build 765 kV power lines in NY state, touching off a controversy that led to the project. Dr. David Savitz of the University of North Carolina in Chapel Hill first announced his study results last November (see *MWN*, November/December 1986).

Many of the key findings of the NY studies have already been reported. These include:

- The proliferation of human tumor cells exposed to ELF fields (see *MWN*, April and September 1984 and July/ August 1986). These results, by Drs. Wendell Winters and Jerry Phillips, were not replicated by Dr. Maimon Cohen in a follow-up study also funded by the project, after the Winters-Phillips results were publicized. A dispute is brewing over whether Cohen followed the same experimental procedures. (This will be addressed in a future issue.)
- Dramatic behavioral effects in rats exposed to weak ELF fields in a static field less than that of the earth's, demon-

NY Power Lines Project Reports

Prasanta K. Basu, *Biological Effects of Extremely Low Frequency Electric and Magnetic Fields on the Ocular Tissues: An In Vitro Study*, 112 pp., $28.00.

Arland L. Carsten, *Mutagenicity and Toxicity of Electric and Magnetic Fields*, 196 pp., $49.50.

Maimon M. Cohen, *In Vitro Genetic Effects of Electromagnetic Fields*, 100 pp., $25.00.

Maimon M. Cohen, *The Effects of Low-Level Electromagnetic Fields on Cloning of Two Human Cancer Cell Lines (Colo 205 and Colo 320)*, 34 pp., $8.50.

Amos G. Gona, *Effects of 60 Hz Electric and Magnetic Fields on the Developing Rat Brain*, 40 pp., $10.00.

Charles Graham and Harvey D. Cohen, *Influence of 60 Hz Fields on Human Behavior Physiology Biochemistry*, 102 pp., $25.50.

Ross Gundersen, Ben Greenebaum and Eugene Goodman, *Effects of 60 Hz Electromagnetic Fields on Calcium Efflux and Neurotransmitter Release*, 46 pp., $11.50.

Gordon K. Livingston, *Reproductive Integrity of Mammalian Cells Exposed to 60 Hz Electromagnetic Fields*, 45 pp., $11.25.

Klaus-Peter Ossenkopp, *ELF Low Intensity Magnetic Fields and Epilepsy*, 52 pp., $18.25.

Gideon A. Rodan, *Effect of 60 Hz Electric and Magnetic Fields on Neural and Skeletal Cells in Culture*, 40 pp., $10.00.

Kurt Salzinger, *Behavioral Effects of ELF*, 137 pp., $34.00.

David A. Savitz, *Childhood Cancer and Electromagnetic Field Exposure*, 178 pp., $45.00.

Richard G. Stevens, *Epidemiological Studies of Cancer and Residential Exposure to Electromagnetic Fields* (50 pp.), and William T. Kaune, *Residential Magnetic and Electric Fields Measured over 24-H Period* (109 pp.), 159 pp., $40.00.

Frank M. Sulzman and David E. Murrish, *Effects of Electromagnetic Fields on Primate Circadian Rhythms*, 65 pp., $16.25.

John R. Thomas and John Schrot, *Investigation of Potential Behavioral Effects of Exposure to 60 Hz Electromagnetic Fields*, 75 pp., $18.75.

Wendell D. Winters, *Biological Functions of Immunologically Reactive Human and Canine Cells Influenced by In Vitro Exposure to 60 Hz Electric and Magnetic Fields*, 105 pp., $26.25.

Jonathan R. Wolpaw, Richard F. Seegal, Robert I. Dowman and Saty Satya-Murti, *Chronic Effects of 60 Hz Electric and Magnetic Fields on Primate Central Nervous System Function*, 165 pp., $41.25.

A complete set of reports costs $419.00. Order from: Charlene McAuliffe, New York State Power Lines Project, Wadsworth Labs, E-297, Empire State Plaza, Albany, NY 12201, (518) 474-7888.

strated by Drs. Abe Liboff and John Thomas (see *MWN*, November 1984).

- Changes in the concentration of neurotransmitter-related metabolites in the cerebrospinal fluid of exposed monkeys, as shown by Drs. Jon Wolpaw and Richard Seegal (see *MWN*, November/December 1985).
- The lack of a positive association between acute non-lymphocytic leukemia and adult exposure to ELF fields at home (see *MWN*, November/December 1986).

Members of the scientific advisory panel who wrote the report were: Drs. Anders Ahlbom (Sweden's National Institute of Environmental Medicine), Ernest Albert (George Washington University Medical Center), Antony Fraser-Smith (Stanford University), Alan Grodzinsky (MIT), Michael Marron (Office of Naval Research), Alice Martin (Northwestern University Medical School), Michael Persinger (Laurentian University), Michael Shelanski (Columbia-Presbyterian Medical Center), Chairman, and Edward Wolpow (Harvard Medical School).

Single copies of the panel's report, *Biological Effects of Power Line Fields*, are available at no charge – while supplies last – from Dr. David Carpenter, School of Public Health Sciences, Wadsworth Labs – E297, Empire State Plaza, Albany, NY 12201, (518) 474-7888. For a list of the individual contractor reports, see the list to the left.

NY State Power Lines Project Summary & Recommendations

SUMMARY

In this section we focus on effects that have been found in the New York-funded projects and which seem worthy of further consideration because of their possible implications for human health.

A. Magnetic Fields

It is clear from the results of the studies sponsored by the Project, as well as from many other recent studies, that both 60 Hz electric and magnetic fields can affect certain biological systems. Magnetic field effects were found in a number of the projects in this program. However, the mechanisms responsible for these effects are unknown. Many effects have been observed at magnetic flux densities in the neighborhood of 100 μT (1 G) or greater. These levels are similar in magnitude to the maximum magnetic flux density directly beneath power transmission lines. Lower magnetic flux density thresholds for most observed field effects have not been determined.

The epidemiological studies raise the possibility that magnetic flux densities one one-thousandth of those shown to have effects in laboratory studies may be a health concern. For several reasons, including the fact that a causal relationship between weak magnetic fields and cancer has not been established and that methodological uncertainties associated with quantifying magnetic field exposure levels exist, we cannot offer a recommendation based on the epidemiological studies. Except for

houses close to power transmission lines, the major sources of magnetic fields in homes are the ground return currents from distribution systems and fields in the immediate proximity of appliances.

B. Neurobiology and Behavior

At the onset of this project there was serious question as to whether there were demonstrable neurobiological or behavioral effects of exposure to electrical and/or magnetic fields. Data accumulated by our contractors as well as a rapidly building literature on retinal magnetoreceptors in birds and mammals leave little doubt that such effects can be observed in well designed experiments.

In contrast, our knowledge of the mechanisms by which these effects are mediated has not advanced significantly. One hypothesis is that several of these effects are mediated via endogenous opioids. However, no data have been obtained to either support or deny this hypothesis. Other effects could be mediated or modulated by changes in the levels or intracellular localization of ionic calcium. The alterations in miniature end plate potential frequency by magnetic fields could be due to small changes in internal ionic calcium. Efflux of calcium from multicellular nervous system preparations reported by other laboratories reflects effects on extracellular calcium, and the physiologic relevance of this calcium store is unknown.

The reliable and specific effects of brief exposures to 60 Hz magnetic fields within a decreased geomagnetic background deserve further attention. Interactions between 60 Hz magnetic fields and the intensity and direction of the static background fields have been suspected by many authors and may be an important source of the variability in occurrence of magnetic field effects. The magnitude of the effect from exposure to the combination of 60 Hz magnetic fields and a reduced geostatic field suggests that geomagnetic fields may interfere with inhibitory behaviors. They would be displayed in situations that required dependence upon subjective estimates of timing and the suppression of impulsive responses.

Our studies have not shown any structural neuropathology in either developing or adult animals. We do not feel that there is a significant risk of structural change at the field intensities normally produced on the ground by power lines.

Accepting that biological effects result from field exposure we are faced with deciding whether these effects might lead to adverse health effects. For most of the findings it must be emphasized that the changes are relatively small. However, some changes, such as the depression of hydroxyindole acetic acid levels in the cerebral spinal fluid seen by Wolpaw and Seegal, are extremely long-lasting. The alterations in circadian rhythms are interesting in that such alterations can be associated with alterations in mood and behavior of subtle types. It is possible that these changes could underlie some of the rather "non-specific" changes which have been reported in the occupational literature on electrical switchyard workers. Certainly, circadian rhythms might be much more suitable parameters to monitor in occupational studies than the more vague subjective responses. A more dramatic effect of fields was the demonstration of a persistent deficit in the response rates of adult rats that had been exposed before and just after birth.

In our studies, no neurobiological effects were seen at field intensities lower than those encountered within the existing right-of-ways of 345 or 765 kV lines. Even those effects encountered were of reasonably small amplitude and could not be said with confidence to indicate health hazards. Our studies are limited in that many of them did not explore weaker magnetic fields or obtain adequate data to determine dose-response characteristics.

C. Cancer

Previous epidemiologic studies on adult and childhood cancer have been questioned because of serious methodological shortcomings. The results of the Savitz study on childhood cancer change the situation considerably because it was designed to minimize flaws in previous studies, and because [the study] was conducted under the supervision of a panel of independent scientists. Even though the Savitz study also has certain limitations, it indicates an excess risk for childhood cancer, in particular leukemias, associated with high current wiring configuration near the homes. Although this study basically confirms the results of the previous studies, the causal relationship is still no more than a hypothesis. However, the basis for this hypothesis is now stronger. The reasons why this is still only a hypothesis are (1) we still only have one well designed study, (2) there are unresolved questions in the Savitz study and (3) there is no basic mechanism known to explain a causal relationship. If future research confirms a causal association between 60 Hz magnetic fields and childhood cancer, public health considerations would have to be developed from (1) baseline risk of childhood cancer, (2) risk increase due to field exposure and (3) distribution of exposure in the population.

On his own initiative, one of the Project investigators undertook studies of the effects of field exposure on the growth of cultured cells in soft agar as measured by the number of clones (colonies) formed. Normal cultured cells do not grow in soft agar unless they are "transformed," and field exposure did not produce transformation. However, the two cancer cell lines tested, which have the inherent ability to grow in soft agar, were reported by the investigator to form more clones after exposure.

Because of the possibility that these results were artifactual, that is, were related not to field exposure but to the inherent variability of the cloning assay, clonogenicity of these same cancer cell lines was examined in a second laboratory. Dr. Hamburger, who participated in the replication study, was the originator of the cloning assay for evaluation of chemotherapeutic agents. In their final report Drs. Hamburger and Cohen report no consistent effects related to field exposure. In the replication study several significant findings are reported but these findings are not reproducibly observed and do not always occur in the same direction, that is in some experiments there are more clones in the control, in other experiments the converse is true.

We conclude that further replications of the influence of fields on the ability of cancer cells to form clones in soft agar are not warranted because: (1) electric and magnetic fields have not been observed to induce transformation in normal cells, (2) exposure of two cancer cell lines in two different laboratories does not provide convincing evidence of an effect of biological significance and (3) extrapolations from the behavior of cancer cells in soft agar to intact organisms cannot be made. Extrapolation of possible field effects on cancer should be done with more relevant assays.

Previous studies were not strongly suggestive of either genetic mutations or chromosomal damage caused by electric or magnetic field exposure. Several independent investigations within the New York State Power Line Projects also failed to find evidence of genetic or chromosomal damage. In light of the epidemiology results future studies on chromosomes should focus on mechanisms of leukemiagenesis, for example oncogenes and promotion. There is currently no convincing evidence for field effects on fertility or growth. Further animal studies would not seem warranted for these variables. Our studies on fetal development have shown no gross morphologic changes. However, the Salzinger results showed persistent changes in

performance of rats that had been exposed *in utero* and immediately after birth. These results may reflect subtle but important alterations of nervous system development that are not reflected in gross morphology.

RECOMMENDATIONS

Research sponsored by this project and related research have demonstrated [a] variety of effects of electrical and magnetic fields. These findings do not readily translate into concrete regulatory recommendations on width of right-of-ways, line heights, or location of lines near homes. They do, however, lead us to the recommendations which follow:

1. There should be a major research effort on means of power delivery and use that would reduce magnetic field exposures.
2. Further study should be made of the interactive effects of the earth's geomagnetic field and 60 Hz fields.
3. The determination of the existence of thresholds for biologic effects of magnetic flux densities should be pursued.
4. The experiments on field effects on learning ability should be replicated.
5. The possible association between cancer (especially leukemias) and magnetic fields must be further investigated. Several avenues of study should be pursued.

a. There should be further epidemiologic study of residential exposure, conducted at more than one site with careful measurement of exposure.
b. Attempts should be made to correlate cytogenetic and diagnostic subgroups of cancers with exposures.
c. Further investigation of occupational exposure and cancer incidence should be conducted with improved documentation of actual exposures.
d. Animal models should be developed and laboratory investigations designed to explore possible mechanisms of field-induced carcinogenesis. If an effect is documented, then the dose-response relationship should be investigated.

6. Further research on the biologic effects of electromagnetic fields is very important. It should be administered by an agency, preferably federal, which is credible by virtue of being clearly independent of partisan influence.

Conference Calendar

New Listings

November 5-7, 1987: **4th Annual Meeting of the American Society of Clinical Hyperthermic Oncology (ASCHO)**, Houston, TX. Contact: Dr. Pierre Greeff, Associate Director, The Stehlin Foundation for Cancer Research, ASCHO, 1315 Calhoun St., Suite 1818, Houston, TX 77002, (713) 659-1336.

November 10-12, 1987: **2nd Annual Society of Broadcast Engineers (SBE) National Convention**, A.J. Cervantes Convention Center, St. Louis, MO. Contact: SBE, PO Box 16861, St. Louis, MO 63105.

January 5-8, 1988: **National Radio Science Meeting**, University of Colorado, Boulder, CO. Contact: Prof. S.W. Maley, Dept. of Electrical Engineering, University of Colorado, Boulder, CO 80309.

January 27-31, 1988: **International Symposium on Work in a Hot Environment and Heat-Related Disorders**, Khartoum, Sudan. Contact: Dr. Moneim Attia, Chief, Occupational Physiologist, Ministry of Health, PO Box 303, Khartoum, Sudan.

April 18-21, 1988: **1988 International Symposium on Radio Propagation (ISRP '88)**, Beijing, China. Contact: Prof. Sha Zong (Z. Sha), China Research Institute of Radiowave Propagation, PO Box 138/88, Xinxiang, Henan, People's Republic of China.

April 19-21, 1988: **International Conference on Lightning and Static Electricity**, Oklahoma City, OK. Contact: Michael Glynn, FAA Technical Support Center, ACT-430, Atlantic City Airport, NJ 08405, (609) 484-4138.

Upcoming Meetings

August 31-September 2: **22nd Annual Microwave Power Symposium: A Macro View of Microwaves and RF Heating**, Hyatt Regency Hotel, Cincinnati, OH. Contact: International Microwave Power Institute (IMPI), 13542 Union Village Circle, Clifton, VA 22024, (703) 830-5588.

September 1-5: **9th International Symposium on Bioelectrochemistry and Bioenergetics**, Szeged, Hungary. This meeting is a Satellite Meeting of the **9th International Union of Pure and Applied Biophysics**, Jerusalem, Israel, August 23-29. Contact: Dr. Lajos Keszthelyi, Institute of Biophysics, Biological Research Center, Hungarian Academy of Sciences, PO Box 521, H-6701, Szeged, Hungary.

September 7-10: **17th European Microwave Conference**, Ergife Palace Hotel, Rome, Italy. Contact: Microwave Exhibitions & Publishers, Ltd., 90 Calverley Rd., Tunbridge Wells, Kent TN1 2UN, U.K.

September 10-11: **International Conference and Workshop on Electromagnetic Interference and Compatibility**, Hotel Taj Residency, Bangalore, India. Contact: Prof. G.R. Nagabhushana, Dept. of High Voltage Engineering, Indian Institute of Science, Bangalore 560 012, India, (812) 364411, ext. 376.

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

September 28-30: **AC/DC Transmission Interactions and Comparisons Symposium**, Boston, MA. Contact: CIGRE, 112 Boulevard Haussmann, 75008 Paris, France, (1) 45-22-65-12.

September 29-October 1: **9th Annual Electrical Overstress/Electrostatic Discharge Symposium**, The Peabody, Orlando, FL. Contact: Michael Martin, 3M/Static Control Systems, 2111 W. Braker Lane, Bldg.501, PO Box 2963, Austin, TX 78769, (512) 834-3117.

October 11-14: **7th Annual Meeting of the Bioelectrical Repair and Growth Society (BRAGS)**, Holiday Inn Downtown, Toronto, Canada. Contact: BRAGS, PO Box 64, Dresher, PA 19025, (215) 659-5180.

October 14-16: **9th International Colloquium on the Prevention of Occupational Risks due to Electricity**, Hotel Melia Castilla, Madrid, Spain. Contact: Berufsgenossenschaft der Feinmechanik und Elektrotechnik, Gustav-Heinemann-Ufer 130, D-5000 Koln 51, F.R.G., (221) 37781.

October 19-21: **International Radar Conference**, London, U.K. Contact: Conference Services, IEE, Savoy Pl., London WC2R 0BL, U.K., (1) 240-1871, ext. 222.

November 2-5: **DOE/EPRI Review of Research on Biological Effects of 50/60 Hz Electric and Magnetic Fields, Air Ions and Ion Currents**, Hyatt Regency Hotel, Kansas City, MO. Contact: W/L Associates, Suite #4, 120 West Church St., Frederick, MD 21701, (301) 663-1915.

NEW BOOKS

Invited Reviews

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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Briefly Noted

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

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

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

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

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

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

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

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

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

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

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

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

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

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

UPDATES

BIOLOGICAL EFFECTS

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

EMP

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

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

GOVERNMENT

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

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

MEASUREMENT

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

MEETINGS

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

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

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

OVENS

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

POWER LINES

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

STANDARDS

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

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

ETC...

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New Listings

Occupational EMF Exposure Again Linked to Brain Cancer

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

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

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

(continued on p.15)

EMP Technician with Leukemia Files Suit Against Boeing

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

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

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

(continued on p.14)

HIGHLIGHTS

BEMS Briefs

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

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

* * * * * *

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

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

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

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

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

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

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

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

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

* * * * * *

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

* * * * * *

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

* * * * * *

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

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

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

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

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

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

bilt University in Nashville, TN.

* * * * * *

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

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

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

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

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

* * * * * *

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

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

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

* * * * * *

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

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

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

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

* * * * * *

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

RF Heating of the Wrist and Ankle

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

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

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

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

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

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

Communications Roundup

Seattle, WA, To Set RF/MW Standard

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

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

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

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

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

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

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

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

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

Hawaii Highway and Omega VLF Station

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

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

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

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

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

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

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

MWN References

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

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

EPA To Measure RF in McFarland, CA

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

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

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

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

FCC Revises NEPA Rules

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

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

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

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

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

EPA-FCC RF Survey in Spokane, WA

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

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

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

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

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

Navy Selects Ocean Site for EMPRESS II

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

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

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

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

CONFERENCES

New Listings

1988

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

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

1989

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

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

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

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

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

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

ELF NEWS

« Power Line Talk »

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

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

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

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

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

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

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

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

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

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

Correction on New Zealand Cancer Study

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

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

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

Sleeping with EMFs

Electric Blankets Shift Menstrual Cycles

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

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

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

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

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

CA Study Finds No Leukemia Risk

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

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

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

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

EMF Exposure and Control

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

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

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

TX Supreme Court Refuses To Review Klein Decision

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

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

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

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

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

Eastern European Literature on ELF Bioeffects

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

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

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

NY Power Authority Prepares for $60 Million Trial

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

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

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

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

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

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

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

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

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

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

NEW BOOKS

Selected Reviews

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

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

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

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

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

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

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

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

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

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

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

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

NEW BOOKS

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

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

Recently Published

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

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

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

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

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

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

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

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

Forthcoming

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

UPDATES

BIOLOGICAL EFFECTS

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

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

COMPATIBILITY & INTERFERENCE

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

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

INTERNATIONAL

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

MEDICAL APPLICATIONS

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

PEOPLE

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

STANDARDS

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

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

ETC...

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

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

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

Representatives from Boeing refused to comment on the case.

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

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

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

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

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

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

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

Montana Tests

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

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

Several EMP technicians who worked in Montana later

EMP Bioeffects Review

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

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

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

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

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

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

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

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

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

Brain Cancer *(continued from p.1)*

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

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

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

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

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

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

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

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

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

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

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

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

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New Listings

ELF-Microwaves and Chemical Promoter Yield Cancerous Cells

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

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

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

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

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

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

(continued on p.14)

OTA on ELF Hazards: "Legitimate Reasons for Concern"

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

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

(continued on p.13)

HIGHLIGHTS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

MWN, D83).

A 1978 epidemiological study of Moscow embassy employees by Professor Abraham Lilienfeld of Johns Hopkins University failed to show any adverse effects, but Lilienfeld urged the U.S. State Department to continue to monitor the health of the Moscow staff over the next few years since only a short time had elapsed between the period of maximum exposure and his study.

More recently, in March 1988, the State Department acknowledged that it had again detected radiation—"primarily" in the 9-11 GHz range—at the Moscow embassy (see *MWN*, M/A88). Although the department would not speculate on the reasons for the transmissions, a number of theories have been offered over the years, including activation of bugging devices, electromagnetic interference and mind control.

Epidemiological Study of VDT Reproductive Risks Funded

On September 1, the Mount Sinai School of Medicine in New York City will launch its long-awaited epidemiological study of reproductive risks among office workers. The National Institute of Child Health and Human Development (NICHD) is sponsoring the $2 million project, which is the first prospective study ever undertaken of pregnancy risks among video display terminal (VDT) operators. The results are due in 1993.

"We will be addressing an important public health question—whether VDTs pose any risk to early pregnancy," Mount Sinai's Dr. Michele Marcus—the principal investigator for the study—told *Microwave News*. Dr. Philip Landrigan, head of Mount Sinai's Division of Environmental and Occupational Medicine, and Dr. Irving Selikoff, the previous division head, are collaborating with Marcus. Selikoff first announced plans for a VDT study in 1985 (see *MWN*, Jn85).

Over the years, the study design has evolved to encompass all aspects of office work, not just VDTs (see *MWN*, M/J87). In addition, the Mount Sinai team will address other VDT health risks such as musculoskeletal and vision ailments.

Many labor and government representatives hailed the government's decision to fund the project, but laced their praise with criticism for the long delays. Congressman Ted Weiss (D-NY), who has been an active supporter of VDT health and safety studies, called it "an important first step," but added that, "There is growing evidence that research which addresses other health risks from VDTs is also long overdue." At an NICHD-sponsored workshop last November, a Weiss aide urged the institute to sponsor a study on reproductive risks in light of the Kaiser Permanente epidemiological study, which showed that women who used VDTs more than 20 hours a week had twice the miscarriage rate of those who did other types of office work (see *MWN*, M/J88 and N/D88).

Senator Albert Gore (D-TN) commented that, "There are still many unanswered questions about the potential health effects of VDTs and of electromagnetic fields (EMFs) generally, but there is no longer any doubt that this form of radiation can cause some biochemical changes. In my view, that information alone is sufficient to warrant a renewed commitment on the part of government and private industry to study this issue and search for solutions to protect people." Gore held a hearing on VDT EMFs in 1981, when he was in the House of Representatives (see *MWN*, Jn81).

"We are incredibly thrilled," Sharon Danann of 9 to 5, the National Association of Working Women, told *Microwave News*. "We think that the study will add a great deal to this area of research," she said. The Service Employees International Union and 9 to 5, as well as a number of large corporations, are assisting Mount Sinai in identifying workplaces to participate in the study.

The Mount Sinai study will be the first to monitor office workers before they are pregnant and throughout the first few months of pregnancy. Marcus and coworkers will follow 8,000 women in New York, Boston, Cleveland and an as-yet-undetermined California city. For one year, approximately 10% of the study population will submit urine samples, which will then be tested for human chorionic gonadotropin—a sensitive indicator of pregnancy. Menstrual cycles and hormone levels will also be monitored.

AT&T Bell Labs, based in Murray Hill, NJ, will work with Mount Sinai on VDT radiation measurements.

In addition to looking at VDT use, the researchers will address the impact of stress, ergonomics and the general office environment. Potential risks due to cigarette smoking, alcohol consumption and caffeine intake will also be investigated.

A pilot study was funded by the National Institute of Environmental Health Sciences and the March of Dimes (see *MWN*, S/O87).

Canadian Study Shows No VDT-Miscarriage Link

Women who used VDTs while pregnant did not suffer an increased incidence of miscarriages, according to a new study from the University of Calgary in Alberta, Canada. Drs. Heather Bryant and Edgar Love of the university's medical school found that there was no association, regardless of the length of time spent at a terminal.

The number of operators who worked at VDTs for more than 20 hours a week was small, however. The researchers noted that their study "lacks power to comment on this single stratum of exposure." Last year a team from Kaiser reported that women who used VDTs for more than 20 hours a week had twice as many miscarriages as those unexposed (see *MWN*, M/J88).

The Calgary results appear in the *International Journal of Epidemiology, 18*, pp.132-138, 1989.

U.K.'s NRPB: Same 0-300 GHz Limits for Workers & Public

Under the U.K.'s National Radiological Protection Board's (NRPB) new guidelines, workers and the general public are subject to the same limits for exposures to non-ionizing radiation. "The board is unable to find a scientific justification for recommending lower basic restrictions for the public in comparison with workers," the NRPB advised in a May report.

The new guidelines only take into account thermal effects. While noting "some epidemiological evidence" of cancer and birth defects risks, the NRPB said that, "It would seem premature to recommend restrictions on exposures to take account of possible cancer risks."

The new recommendations have no legal force. "It's our advice," Dr. Alastair McKinlay, head of Physical Dosimetry for the NRPB, told *Microwave News*.

An editorial appearing in the May issue of the NRPB's *Radiological Protection Bulletin* pointed out that the electromagnetic fields (EMFs) from domestic appliances—e.g., heaters and kettles—are often greater than fields that arise from power lines. "A ban on the use of electricity would not be feasible, useful or welcome," it stated.

The editorial went on to comment that the "as low as reasonably achievable" (ALARA) strategy "is hardly useful when there is no way of quantifying the reduction in the possible risk against the costs, inconvenience and effectiveness of reducing existing exposures levels."

The recommendations, which cover extremely low frequencies (ELF) up to microwaves, came in response to the guidelines put forward by the International Non-Ionizing Radiation Committee (INIRC) of the International Radiation Protection Association (IRPA) (*see MWN*, M/A87 & J/F88).

Unlike the IRPA guidelines, the NRPB's "basic restrictions" are specified in terms of induced currents and specific absorption rates (SARs)—instead of electric and/or magnetic fields and power densities. The NRPB stressed that the currents and SARs are based on "reference levels" adapted from IRPA's EMF limits. But these reference levels "are not to be regarded as limits" and cannot be enforced.

In an interview with *Microwave News*, Stuart Allen of the NRPB's office in Leeds, U.K., acknowledged that there are no off-the-shelf devices now available to measure the quantities specified in restrictions 1-5 (see box at right). He added that, "If you exceed the reference levels, it does not necessarily mean that you would exceed the basic restrictions. The implication is that if you exceed the reference levels, you need to do further investigations on the characteristics of the particular exposure situation." Allen is the group leader of the NRPB's EMF Study Group.

Dr. John Male of Central Electricity Research Laboratories in Leatherhead, U.K., told *Microwave News* that the 50 Hz limits recommended by the NRPB "are not going to cause us any embarrassment—we can live with them." He said that he agrees that a distinction between workers and the general public is not necessary.

Guidance as to Restrictions on Exposures to Time Varying Electromagnetic Fields and the 1988 Recommendations of the International Non-Ionizing Radiation Committee, NRPB-GS11, is available from: Publications Officer, NRPB, Chilton, Didcot, Oxfordshire, OX11 0RQ, U.K.

NRPB: Basic Restrictions on Exposures to EMFs Below 300 GHz

1. The continuous induced current in any arm, hand, leg, ankle or foot should not exceed:

   $$\left[1 + f/1500\right] \text{ mA or } 100 \text{ mA}$$

   whichever is smaller for frequency f less than 30 MHz; f is in Hz.
2. The average specific energy absorption rate in the body over any 6 min should not exceed 0.4 W/Kg.
3. When taken in conjunction with 2 above, the maximum value of the specific energy absorption rate in any 0.1 Kg of an internal organ or tissue in the head or trunk over any 6 min should not exceed 10 W/Kg.
4. When taken in conjunction with 2 above, the maximum value of the specific energy absorption rate in any 0.1 Kg of an arm, hand, leg, ankle or foot in any 6 min should not exceed 20 W/Kg.
5. Exposures to time-integrated power densities in any pulse of duration less than 50 μs exceeding 0.4 J/m² should be neither prolonged nor frequent.
6. Radiofrequency burns from objects in the field should be avoided.
7. Any uncomfortable sensation of heat in the superficial layers of the body should be avoided at frequencies above 1 GHz.

Navy Seeks Winter Site for EMPRESS II

The U.S. Navy is planning a winter site for its electromagnetic pulse (EMP) simulator, EMPRESS II, in the Gulf of Mexico, 30-60 miles off the coasts of Mississippi and Alabama. The Navy seeks to operate the simulator approximately 60 days during the months of November through April.

The Navy is currently preparing an environmental assessment for the site and expects to complete all of its environmental reviews by October 1, 1990. It has already filed an environmental impact statement for the operation of EMPRESS II off the coast of Virginia (see *MWN*, M/J88).

EMPRESS II—an acronym for the second Electromagnetic Pulse Radiation Environment Simulator for Ships—has been at the center of a controversy over health and interference effects for the last five years (see *MWN*, O84, N84 and

J/F87). The Navy originally intended to use the simulator on Chesapeake Bay, but finally gave up in the face of intense opposition from citizens and elected officials in Maryland and Virginia. The simulator was ultimately located on the Atlantic Ocean, 15 miles off the coast of North Carolina (see *MWN*, J/A88).

In an interview with the *New Orleans Times-Picayune*, EMPRESS II Project Manager Captain W.E. Mayhew blamed the Navy's troubles at the Chesapeake Bay site on a failure to "head off initial misinformation." He added that the local politicians were "victims of our failure to get out good information." Three public meetings were held in Mississippi, Alabama and Louisiana at the end of June to brief local residents.

A recent analysis by the Congressional Office of Technology Assessment (OTA) concluded that EMPRESS II, in its Atlantic Ocean site, presented "no significant health effects" threat to humans and wildlife, but recommended further testing to determine possible electromagnetic interference (EMI) to avionics (see *MWN*, J/F89).

The proposed site is located away from airports and commercial air corridors and thus would pose no EMI threat to aircraft, the Navy told *Microwave News*.

The Navy's plans have not been well-publicized. Indeed, when asked by *Microwave News* about the southern site, a Navy spokesperson replied, "Good Lord! They're not going to drag that thing all the way around Florida?"

AMA Seeks EMP-Resistant Medical Devices

In a new policy statement, the American Medical Association (AMA) encourages the development of medical devices that are resistant to electromagnetic pulse (EMP) radiation. The AMA's House of Delegates approved a staff report on the effects of EMP at its June annual meeting (see *MWN*, S/O88).

It is not clear whether the report will be published, but the AMA's Dr. Theodore Doege, the report's author, told *Microwave News* that it "definitely represents AMA policy." The seven-page report identifies electronic equipment for monitoring life-support systems, lab instruments, computers, communications and emergency power-generating systems as among those devices most vulnerable to EMP. Diagnostic equipment, such as magnetic resonance imagers, might also be affected.

Over the years, the U.S. Army has funded research on protecting medical devices from EMP (see *MWN*, J/F86 and J/A87). In 1985, the Food and Drug Administration reported that many computerized medical devices are susceptible to electromagnetic interference (see *MWN*, N/D85).

The new report also calls for the AMA to support the recommendations of the National Security Telecommunications Advisory Committee's task force on EMP and urges that they be adapted to the medical sector (see *MWN*, S/086).

EMC Rules Around the World

The Netherlands Standardization Institute (NSI) in Delft has published a handbook, *Electromagnetic Compatibility [EMC]—Regulations and Standards Worldwide*, a highly useful compilation of EMC rules and legislation from 69 countries and territories—from Algeria to Zimbabwe. It also covers international standard-setting groups.

The guide includes rules for household electrical appliances, fluorescent lights, computers, radio and TV receivers, RF and ISM equipment and automobile ignition systems.

H.Th.C. Haus of the Nederlandse Philips Bedrijven edited the 207-page handbook.

Copies are available by special order for $55.00 each from: Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018, (212) 354-3300. Allow extra time for shipping and handling. For further information on the NSI, contact: Mrs. P.J.A. van Heeswijk, Public Relations Dept., NNI, PO Box 5059, 2600 GB Delft, The Netherlands, (015) 690 390.

ELF NEWS

« Power Line Talk »

Philip Abelson's editorial in *Science* making the case for more EMF research funds inspires considerable irony. Three years ago in that same space, Dr. **Granger Morgan**, who heads the Carnegie Mellon team that wrote the OTA report (which in turn prompted the *Science* editorial), raised the question of when to *stop* risk-related research, using 60 Hz EMFs as an illustration (see *MWN*, M/J86). And in late 1987, *Nature*, *Science*'s principal competitor, published a commentary by Drs. **Kenneth Foster** and **William Pickard** suggesting that the time had indeed come to stop low and high frequency EMF research (see *MWN*, J/F88). Of course, all that has now changed.

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Building new transmission lines in the U.S. is getting harder every year. In a recent analysis of electric utilities industry trends, **Morgan Stanley**, an investment banking firm, reports that right now it may be more difficult to get regulatory ap-

proval to build power lines than to build generating facilities. Analyst Sanford Cohen points out that industry experts believe "a large transmission project could take 20 years from conception to completion." He also notes that over the last four or five years, U.S. transmission line construction has "dropped considerably": In 1984, transmission capacity grew at a rate of four percent, but by 1987, growth had shrunk to one percent.

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Dr. **Robert Becker**'s forthcoming book will be titled ***Cross Currents: The Promise of Electromedicine, The Peril of Electropollution.*** The publisher, Jeremy P. Tarcher, Inc., is planning to have it in bookstores by the beginning of 1990.

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Potomac Electric Power Co. (**PEPCO**), which serves the Washington, DC, area, estimates that it would cost $1.3 billion—at $100,000 per mile—to bury all of its overhead lines. In a letter to the July 8 *Washington Post*, PEPCO's H.J. Pulizzi listed the vulnerabilities of underground lines, including risks from construction and garden digging, lawn fertilizers, snow-melting chemicals, rodents, water and heat. He stated that, for "aesthetic reasons," PEPCO—along with most other U.S. utilities—has been installing underground cables in new residential areas for years, even though finding and repairing underground line problems can be "agonizingly slow."

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Dr. **Stephen Perry** has reaffirmed the link between power line EMFs and **depression**. His latest paper, published in *Public Health* (*103*, pp.177-180, 1989), provides new support for this association, which he first described in 1979 (see *MWN*, D81). He does not observe an association with heart disease, which he reported last year (see *MWN*, N/D87). This will probably be Perry's last research paper in this area. In a letter to *Microwave News* from his home in Wolverhampton, U.K., Perry said that, in order to continue his work, he would need "monitoring equipment which is too expensive." Perry hopes that someone will pick up where he has left off.

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Two more indicators that EMFs have become a key issue for utilities: The ***First Annual Transmission Symposium***, to be held in Washington, DC, September 25-26, will feature a session on health and environmental effects. Scheduled to speak are an attorney for the New York Power Authority, which is waiting for a decision in the Marcy-South trial, and an analyst from the Office of Technology Assessment, which just released its much talked about report on EMF bioeffects. And in its latest issue, *Environment Update*, a newsletter published quarterly by **EPRI**, EMFs gets more ink than either air or water pollution.

"Science" Magazine Calls for More 60 Hz Health Research

Science, the leading U.S. magazine covering scientific issues, has called for increased support of research into the health effects of electromagnetic fields.

In an editorial appearing in the July 21 issue, Philip Abelson, the magazine's deputy editor, writes, "The situation calls for much more effort in research than has hitherto taken place." He recommends "more animal studies and substantial epidemiological studies, coupled with accurate measures of fields."

The editorial was prompted by the Office of Technology Assessment (OTA) report (see pp.1 and 15). Abelson cites the OTA strategy of adopting a "prudent avoidance" strategy—that is, minimizing exposures when the costs of doing so are justified.

Florida Judge Bars Students from Playing Near Power Lines

In an unusual decision which could affect future zoning policies, a Florida judge has ruled that children may not play in a Boca Raton school yard which borders on high voltage power lines. The suit was brought by three local parents who sought to close the Sandpiper Shores school because of potential electromagnetic field (EMF) health hazards (see *MWN*, S/O88, J/F89 and M/J89).

"The evidence is clear that both electric and magnetic fields affect the human body," although the "connection between EMFs and cancer is still very much up in the air," Judge Timothy Poulton of the Palm Beach County Florida Circuit Court ruled on June 8.

The judge decided that the school may remain open, but he reserved the right to review the case "upon a change of circumstances"—for example, if the upcoming National Cancer Institute study shows an association between EMFs and cancer (see *MWN*, J/F89), or if future measurements show higher EMF levels than those presented at the trial. The judge also ordered the county school board to measure nearby EMF levels every month.

Many schools around the country are near high-voltage power lines. For instance, the Sandpiper school is one of 24 in Palm Beach County located near such lines, according to local reports.

At the trial, Fred Dietrich, an engineer with Electric Research & Management in State College, PA, who testified on behalf of the school board, claimed that the average magnetic field levels in the school for a "realistic worst-case scenario"—41% of line capacity—would be approximately 1.13 mG. Dr. Andrew Marino of LSU Medical Center in Shre-

veport, LA, who testified for the parents, estimated that, using his worst-case assumptions—100% capacity—the levels would be 3.3 mG. The court leaned towards Dietrich's estimate; the judge said that his worst-case estimate was 1.55 mG.

The judge discounted some of the evidence presented by the school board's witnesses "because of [their] financial ties...to the power industry." Among the school board's other witnesses were Drs. Edwin Carstensen, Philip Cole, William Feero, Dwight Mercer and Morton Miller. Also testifying for the parents were Drs. Harris Busch, Jerry Phillips and Stephen Smith.

The judge noted that children have "no choice" about going to school and therefore EMF exposure at school is an involuntary risk: "A 1% chance that there is substantial danger is unacceptable."

Robert Rausch et al., v. School Board of Palm Beach County, FL, 15th Judicial Circuit Court in and for Palm Beach County, FL, Case No.CL-88-10772-AD, June 8, 1989.

California School Policy

On the other side of the U.S., the California State Department of Education recently adopted a policy for siting schools near power lines, noting that a "conservative approach" should be taken when evaluating sites near power line easements. The department's School Facilities Planning Division limits for schools are: 100 feet from the edge of easement for 100-110 kV lines, 150 feet for 220-230 kV lines and 250 feet for 345 kV lines (see *MWN*, M/J88).

The policy appears in *School Site Selection and Approval Guide,* p. 4, 1989; for more information, contact: Duwayne Brooks, School Facilities Planning Division, California Department of Education, PO Box 944272, Sacramento, CA 94244, (916) 322-2470.

Cancer Studies of Animals To Begin Soon in U.S. & Canada

The first major studies of the cancer risk in laboratory animals exposed to power frequency magnetic fields are about to be launched in the U.S. and Canada. In June, the Electric Power Research Institute (EPRI) issued a request for proposals (RFP) for a four-year study to begin at the end of 1989. Health and Welfare Canada, Ontario Hydro and Hydro-Québec issued their RFP in April, with applications due July 1. The results of the joint Canadian government–utility effort are expected in 1992.

The U.S. government's National Toxicology Program (NTP) is also planning its own studies of power line carcinogenicity.

For the past few years, researchers have been calling for whole animal experiments to support or refute epidemiological findings. At a May 14 workshop convened by the National Academy of Sciences-National Research Council, Dr. David Carpenter of the New York Department of Health argued that animal studies are essential in order to find out the magnitude of the leukemia and brain cancer risks associated with exposures to extremely low frequency (ELF) electromagnetic fields (EMFs) (see *MWN*, M/A89).

EPRI

The EPRI study will use strains of laboratory mice with high intrinsic incidences of leukemia and/or brain cancer to determine whether ELF fields can act as cancer initiators, promoters or as co-carcinogens. Ionizing radiation—a known carcinogen—will be used to help distinguish among these mechanisms of interaction.

The magnetic field intensities used in the experiment will be chosen to "simulate the values found in diverse residential and occupational environments." Mice will be exposed to nine combinations of magnetic fields and ionizing radiation: less than 1 mG, 100 mG and 10 G varied with 0, 0.2 and 1 Gy.

New Zealand Study Supports Electrical Work-Cancer Link

A new epidemiological study reaffirms an earlier finding showing an elevated leukemia risk among New Zealand electrical workers. The research team, which was led by Dr. Neil Pearce of the Department of Community Health at the Wellington School of Medicine in Wellington, New Zealand, also found that the increased risk was primarily for chronic—rather than acute—and lymphatic—rather than myeloid—leukemia. Radio and TV repairers, electricians, linemen and power station operators were at the greatest risk.

In general, there was no evidence of increased risk of other types of cancers, although there was some indication of a higher risk of brain tumors among electrical engineers and electricians. The researchers point out, however, that the findings for specific categories of electrical work should be regarded with caution because of the small number of cases studied.

The team concludes that the results are consistent with other occupational studies suggesting a link with electromagnetic field (EMF) exposures, but cautions that "interpretation is difficult in the current absence of quantification of 'typical' exposures to [EMFs] experienced in these types of electrical work." They note that more detailed studies with exposure assessments are under way in New Zealand.

The study appears in the *International Journal of Epidemiology, 18,* pp.55-59, 1989.

In the April 6, 1985 issue of *The Lancet,* Pearce and coworkers first reported unexpectedly high rates of leukemia among certain New Zealand electrical workers (see *MWN*, My85). Pearce issued a brief correction to the survey in the July 2, 1988 issue of the journal (see *MWN*, J/A88).

The EPRI initiative follows a recommendation for animal studies from an expert advisory group convened by EPRI in San Diego, CA, in 1987 (see *MWN*, M/A87). The specific study design was conceived at an EPRI workshop attended by cancer researchers and held in Carmel, CA, in July 1988.

"This animal study is a key element in EPRI's program to understand apparent associations between power line EMF exposure and cancer, as has been reported in humans," Dr. Charles Rafferty, a project manager in EPRI's radiation studies program told *Microwave News*. He noted that to provide the needed statistical power, the study will be large. "We want the study to be of exceptional quality," he said.

Proposals in response to RFP2965-11 on "Leukemia and Brain Cancer in Animals Exposed to 60 Hz Magnetic Fields" were due by mid-August and EPRI expects to award the contract in October.

For more information, contact: Dr. Charles Rafferty, Radiation Studies Program, EPRI, 3412 Hillview Avenue, Palo Alto, CA 94303, (415) 855-8908.

Canada

The Canadian project is very similar to the EPRI study. Either ionizing radiation or a chemical carcinogen will be used as an initiator. The study will use 1,000 mice, divided into five exposure groups—0, 20 mG, 200 mG, 2 G and 20 G. The mice will be exposed ten hours a day for 80 weeks.

"The study will cost approximately $1.3 million [Canadian]," Dr. Maria Stuchly of Health and Welfare Canada told *Microwave News*, with each of the government and utility sponsors contributing equal shares.

For more information, contact: Dr. Maria Stuchly, Bureau of Radiation and Medical Devices, Health and Welfare Canada, Room 66, HPB Building, Tunney's Pasture, Ottawa, Ontario K1A 0L2, Canada, (613) 954-0306.

NTP

At the NTP, Dr. Rajendra Chhabra is developing a protocol for a carcinogenicity study of ELF fields in rodents. When completed, the protocol will be evaluated by a committee which ranks toxicity studies according to funding priorities.

"We hope that the Department of Energy will contribute some funds for this study," Dr. Richard Griesemer, the director of the National Institute of Environmental Health Sciences' (NIEHS) division of toxicology research and testing, told *Microwave News*.

The NTP coordinates research for the U.S. Department of Health and Human Services, including the NIEHS, the Food and Drug Administration and the National Institute for Occupational Safety and Health. Dr. David Rall, the director of the NIEHS, also serves as the director of the NTP.

For more information, contact: Dr. Rajendra Chhabra, NTP, [A0-01], PO Box 12233, Research Triangle Park, NC 27709, (919) 541-3386.

Around the U.S. and Canada...

California...In a draft report, the Public Utilities Commission (PUC) agreed that further studies on EMF health effects are needed, but stopped short of recommending regulatory action: "Too little is known to be able to determine where or what rule would provide useful protection." The report, *Potential Health Effects of Electric Power Facilities*, issued in cooperation with the state Department of Health Services (DHS), was ordered last year by the state legislature (see *MWN*, M/J88, S/O88, N/D88 and M/A89). A portion of the report lists three high priority projects identified by DHS (see box on p.9). The report, which was originally due March 15, will be submitted to the legislature by September 15. The PUC and the DHS held three public meetings in the first week of August in San Francisco, Los Angeles and Sacramento. A copy of the draft report is available for $20.00 from: Documents Section, California PUC, 505 Van Ness Ave., San Francisco, CA 94102, (415) 557-1812.

Kentucky...In Mason County, a dairy farmer and his wife have settled a damages suit against Kentucky Power Co. after claiming that stray voltage from power lines 150 feet from their milking parlor was responsible for dairy production losses. David and Brenda Polley, whose home is 330 feet from the lines, also sued over potential human health effects from EMF exposures. The terms of the June settlement are confidential, Charles Kirk, the Polleys' attorney, told *Microwave News*. Kirk, who is with Royse, Zweigart, Kirk & Brammer in Maysville, said that the amount originally sought by the Polleys was $100,000.

Minnesota...A Rochester real estate broker who has been fighting a 161 kV line located within 97 feet of his home was awarded $17,500 in damages by a jury. Jim Kuehl took his case to court after unsuccessfully attempting to persuade the Rochester Public Utility to choose an alternate route for the line. The utility originally offered Kuehl $400 for an easement, and a few years later $3,760, both of which he turned down. In 1988, Kuehl—who lives with his two sons—initiated an eminent domain proceeding against the utility and received $11,500. He next appealed to the district court, seeking $80,000 in damages and claiming that the EMFs from the line posed a hazard to the health of his family and decreased the value of his property. Dr. Andrew Marino testified on Kuehl's behalf at the trial. The utility was also ordered to pay for Kuehl's expert witness and appraisal fees. Kuehl now intends to launch a power line public awareness campaign. "We have never been after money," he told *Microwave News*. "We just don't want the line so close to our home."

New Jersey...Residents and town officials in Middletown Township are engaged in a bitter struggle with Jersey Central Power & Light (JCP&L) over a new 9.8 mile 230 kV power line scheduled to go up along a commuter rail ROW. The proposed route goes through a heavily populated area and passes near two schools, according to Mary Cashen Purcell, one of the founders of the citizens' group Residents Against Giant Electric (RAGE), which was formed to fight the line. When JCP&L first introduced its proposal to the public at a March 13 town meeting, local officials raised questions about potential impacts, Committeewoman Rosemarie Peters told *Microwave News*. The utility then successfully sought to have the line classified as "contested" and transferred to the jurisdiction of the Office of Administrative Law, where a judge has scheduled a hearing for October 23. Two public hearings will also be held—in conjunction with the Army Corps of Engineers—to provide the public with an opportunity to comment. Melvin Greenberg of the Newark, NJ, law firm of Greenberg, Dauber & Epstein is representing the township—Drs. Andrew Marino, John Norgard and Lewis Walker will testify for the township at the October hearing. In an information packet distributed to the public, JCP&L, which is also fighting to build a power line in nearby Little Silver, quotes Dr. Philip Cole: "Power lines are not an important factor in public health." RAGE is launching its own public awareness campaign, Cashen Purcell said.

New Jersey...A bill that would require utilities to prepare environmental and public health reviews and to demonstrate that there are no feasible alternatives before building new power lines cleared the state Assembly Committee on Conservation, Natural Resources and Energy in July. Bill A-4783, which was sponsored by Assemblypersons Joe Kyrillos, Jr. and Joann Smith, was prompted by an ongoing dispute over a proposed power line in Middletown (see above). If adopted, the measure will only apply to contested lines of at least 138 kV. For more information, contact: Assemblyman Joe Kyrillos, Jr., One Arin Park Bldg., 1715 State Highway 35, Middletown, NJ 07748, (201) 671-3206.

New York...During half of 1988, the mean magnetic field exceeded 24.8 mG at the edge of a 345 kV ROW, according to a survey of *Magnetic Field Levels Associated with 345 kV Transmission Circuits in New York State*. It exceeded 41.2 and 52.4 mG 10% and 1% of the year, respectively. The *maximum* fields were approximately three times higher in each case. Field levels measured one foot above 345 kV underground lines were on the order of 1 mG during normal power flow. These survey results were presented at a July 26 Technical Conference in Albany, in order to assist the PSC staff in setting an interim magnetic field standard (see *MWN*, M/A88). In April 1988, the PSC concluded that such a standard should be set to ensure that magnetic fields at the edge of future ROWs be "no greater than the fields typical of the many existing 345 kV lines operating throughout the state." The commission's EMF Committee plans to draft an interim standard by the end of 1989. For more information, contact: Dan Driscoll, Office of Energy Conservation and Environmental Planning, NY PSC, Three Empire State Plaza, Albany, NY 12223, (518) 474-5368.

Proposed California Research

The California Department of Health Services (DHS) is proposing three research projects to be funded by the $2 million allocated for EMF research by the state legislature (see *MWN*, S/O88):

- An extension of an ongoing National Institutes of Health-funded study of childhood brain cancer under the direction of Dr. Susan Preston-Martin at the University of Southern California (USC) in Los Angeles. The study was originally designed to investigate the effects of nitrates. Now, questions related to EMF exposure will be added and residential measurements will be made. Approximate added cost: $700,000.
- New measurements of all the "high current configuration" homes in Denver included in the Savitz study, together with a random sample of "low current configuration" homes. Bill Kaune of Enertech, Inc. in Campbell, CA, will direct the survey of a total of 80 homes with the assistance of USC's Preston-Martin. Approximate cost: $300,000.
- An expansion of an ongoing Kaiser Permanente study of the link between spontaneous abortions and drinking (bottled and tap) water. This study, which will be co-directed by Kaiser's Dr. Robert Hiatt and DHS's Dr. Ray Neutra, will now be able to detect relative risks of 1.7 for electric blankets and 1.5 for water beds. The study will include measurements of EMF exposures of a random sample of 200 women. Indices of VDT exposure will be added. Approximate added cost: $800,000.

Alberta, Canada...On May 12, the Energy Resources Conservation Board ruled in favor of routing a 240 kV power line along an existing ROW—the first choice of both TransAlta Utilities Corp. and those citizens concerned about health hazards. In its decision, however, the board disregarded the health effects issue, concluding that "biomedical research and epidemiological studies do not demonstrate harmful biological effects caused by [60 Hz EMFs] associated with high-voltage transmission lines" and that "the question of health effects should not influence its decision on the placement of the line." At hearings held last November, Drs. William Bailey and Jack Mandel testified on behalf of TransAlta.

British Columbia, Canada...Following a July 11-14 public inquiry, the BC Utilities Commission allowed BC Hydro to complete the disputed 230 kV Dunsmuir-Gold River power

line, but ordered it to extend its offer to buy the homes along the ROW until September 15 (see *MWN*, M/J89). According to the commission's July 26 *Report and Recommendations*, which accompanied the commission order, 66 of the 144 property owners who received a buy-out letter accepted the utility's offer, but the utility also received approximately 140 responses from other homeowners. The commission denied a request to move the line, but noted that, "BC Hydro may find it advantageous to consider rerouting its transmission lines at a future date." "Our plan is to proceed with the line. We've nothing more to say beyond that," BC Hydro's Peter McMullan told *Microwave News*. The inquiry was prompted by numerous complaints from local residents concerned about potentially higher levels of EMFs from the new line. Dr. Andrew Marino, testifying on behalf of a citizens group, questioned the credibility of utility-funded studies and said that he considers a "safe level" of electric and magnetic fields to be 50 V/m and 1-2 mG, respectively. Drs. Antonio Sastre and Linda Erdreich, both of ERI, Inc., were among BC Hydro's expert witnesses. In its report, the commission said that, "It is clear that some results emerging from the studies conducted to date give reason for concern," but it concluded that there is "insufficient evidence to support a presumption of an actual health risk" and countered Marino's statements, calling them "strident sweeping allegations." Commenting that the utility acted "imprudently" in offering a buy-out, the commission ordered the utility to "exclude the net cost of the buy-out program from their cost of service" to ensure that "no precedent is established." It also recommended that BC Hydro collaborate with the BC Ministry of Health to devise and fund research programs already under way on EMF effects.

UPDATES

COMPATIBILITY & INTERFERENCE

EMI Did Not Cause Accidental Bomb Drop... The USAF is "99% sure" that a worn-out, malfunctioning bomb rack was to blame for the May 4 accidental bomb drop by an F-16 jet over western Georgia (see *MWN*, M/J89). There had been speculation that EMI might have triggered an electro-explosive device aboard the F-16, releasing the 500-pound bomb. But a spokesman at Moody AFB told *Microwave News* that, although the USAF cannot absolutely rule out other causes, it is almost certain that EMI was not a factor in the accident.

FCC News... The FCC has denied three petitions challenging its newly revised Part 15 rules, which govern the use of such non-licensed RF appliances as remote control units, garage door openers and cordless telephones (see *MWN*, M/J89). In its June 19 order, the FCC ruled that Sensormatic Electronics Corp., Linear Corp. and the American Radio Relay League "failed to meet the criteria necessary to obtain a stay of an administrative action."...CBEMA calls *TP-5*—the FCC's proposed procedure for measuring emissions from digital devices—a "substantial organizational improvement over its predecessor, *MP-4*"—even though it requires "certain modifications" (see *MWN*, M/A89 and M/J89). CBEMA favors the proposal because it "distinguishes measurement procedures on the basis of size and physical characteristics, rather than the intended environment of use or the applicable emanation limits."...And on July 31, the FCC announced that it had initiated a proceeding to update its rules governing the importation of RF devices capable of causing interference. For more information, contact Richard Engelman at the FCC's Field Operations Bureau, (202) 632-6345.

EMP

Army To Move Woodbridge Simulators... The U.S. Army has announced that it will no longer operate EMP simulators at its Woodbridge Research Facility in Virginia, which is operated by the Harry Diamond Labs. The Woodbridge EMP simulators have been shut down since May 1988 as part of a legal settlement which required environmental assessments for most DOD EMP facilities (see *MWN*, M/J88 and J/F89). The Army is considering moving the EMP simulators, although a new location has not yet been announced. In July, the Army released the results of an environmental assessment of the Woodbridge facility, whose mission is to "solve a broad spectrum of nuclear weapons effects and Army systems survivability problems." The assessment does not address the EMP simulators since they will be relocated. No significant environmental impacts were identified. The facility, which is approximately 25 miles southwest of Washington, DC, lies adjacent to nine military family housing units which are scheduled to close by 1995. An elementary school is located about one-half mile away. The commander of the Harry Diamond Labs acknowledged to the *Washington Post* (July 13) that the densely populated neighborhood around the Woodbridge installation is not the place for high-power EMP testing. For more information, contact: U.S. Army Lab Command, ATTN: AMSLC-PA, 2800 Powder Mill Rd., Adelphi, MD 20783, (202) 394-3590.

MEASUREMENT

Electric Field Probe on the Market...A broadband electric field probe developed by engineers at NIST is now being marketed by Electro-Mechanics Co. of Austin, TX, as part of a total measurement system. The probe can measure fields between 1 and 1000 V/m, from 1 MHz to 10 GHz, and is only 8.41 cm long and 1.75 cm in diameter. The system—which consists of a probe, a metering unit and a data processing/interface unit—costs $7,585. Foreign orders are $8,345. NIST's Drs. Motohisa Kanda and Lanny Driver, who designed the probe, described it in detail in "An Isotropic Elec-

tric-Field Probe with Tapered Resistive Dipoles for Broad-Band Use, 100 kHz to 18 GHz," which appeared in the February 1987 issue of *IEEE Transactions on Microwave Theory and Techniques* (see *MWN*, J/F87). For more information on the Model 7100 Broadband Isotropic Probe System, contact: Electro-Mechanics Co., PO Box 1546, Austin, TX 78767, (512) 835-4684, or (800) 253-3761 (outside of TX). For a copy of the NIST paper, contact: Dr. Motohisa Kanda, NIST, Division 723.03, 325 Broadway, Boulder, CO 80303, (303) 497-5320.

Military Standards...NIST researchers J.E. Cruz and E.B. Larsen recommend that, when doing testing for military standards, "shielded rooms should be used only when it is not feasible to use other facilities, such as an open area field site or a fully loaded screenroom." They outline possible ways for improving measurement methods in a new report, *Alternative Techniques for Some Typical MIL-STD-461/462 Type of Measurements*, NIST Technical Note 1320. Copies are available for $2.50 each from the Government Printing Office, Washington, DC 20402. Order No.003-003-02946-7....Ed Aslan of the Narda Microwave Corp. in Hauppauge, NY, describes a system for the calibration of electromagnetic radiation monitors in accordance with the requirements of MIL STD 45662 in a paper appearing in the latest issue of *The Journal of Microwave Power & Electromagnetic Energy, 24*, pp.102-107, 1989.

MEDICAL APPLICATIONS

Preventing Osteoporosis with PEMFs...A team of researchers led by Dr. Clinton Rubin of the Musculo-Skeletal Research Lab at the State University of New York in Stony Brook, NY, has found that short, daily periods of exposure to PEMFs may reverse the trend of osteoporosis caused by a lack of mechanical stimulation. The team studied a population of mature male turkeys whose wing bones were incapacitated through surgery. The turkeys were divided into seven exposure populations: five groups exposed to PEMFs (3 msec bursts at a repetition rate of 1.5 Hz, each burst containing 120 repetitions of an asymmetrical pulse) at one of five different intensities, one group with inactive coils and one with no coils. In all the groups, the turkeys' second wing served as the control. The birds were exposed for one hour a day, five days a week over an eight-week period. The cross sections of the bones revealed that there was "an effective window of [PEMFs] in which bone mass can be controlled in the absence of function"—bone mass was increased 12.3% in one of the exposure groups. The team believes that PEMFs influence the behavior of the cell populations responsible for bone regeneration "because of the physiological characteristics of the signal." In contrast, the study group exposed to inactive coils showed a bone mass *reduction* of 10.8%, as compared to the controls. This figure was not significantly different from the 13% bone loss observed in the control group. The researchers conclude that their data suggest a "potential role for the use of PEMFs in the prevention of loss of bone" in immobilized patients and in the elderly. "Prevention of Osteoporosis by Pulsed Electromagnetic Fields" appeared in the *Journal of Bone and Joint Surgery, 71*, pp.411-417, March 1989.

MRI Safety... Dr. G. Jerome Beers of the Boston University Medical Center in Boston, MA, has published a major review article on the bioeffects of weak EMFs, with special emphasis on magnetic resonance imaging (MRI) and magnetic resonance studies (MRS). He concludes that, "Research specifically on MRI and MRS devices has so far failed to demonstrate significant harmful effects at 1.5 T or less. It may, therefore, be rather conservative for a recent NIH panel to have recommended caution in using MRI on pregnant patients. Whether such conservatism should extend to pregnant MR personnel is not clear....Nevertheless, careful attention to further developments in relevant research would seem reasonable, along with possibly an increase in scientific dialogue within the MR community concerning the subject." Beers also suggests that "MRI and MRS researchers might want to consider the subject as an area to which they could contribute." The review appears in *Magnetic Resonance Imaging, 7*, pp.309-331, 1989....And in the June 16, 1989 issue of the *Journal of the American Medical Association*, Drs. Frank Shellock and Howard Bierman comment on the recent relaxation of the FDA's rules for exposures to MRI EMFs. (See also *MWN*, M/J86, M/J87 and J/A88.)

Microwaves for the Prostate... English doctors, picking up on research developed in Israel, are using microwave radiation to treat prostate problems, including cancer. The *New Scientist* reports in its May 27 issue that while some European researchers see great promise in this type of hyperthermia treatment as an alternative to major surgery, others are more skeptical. According to the article, as many as 30% of all U.S. males over 60 have a prostatectomy, in which most of the gland is removed.

Resources... The July 1989 issue of the *IEEE Transactions on Biomedical Engineering* is devoted to functional electrical stimulation—used to enhance or restore neurological function. Drs. Gideon Kantor of the FDA and Charles Robinson of the VA Hospital in Hines, IL, were the guest editors....Drs. Richard Magin and Andrew Peterson, both of the University of Illinois in Urbana, present an invited review of "Noninvasive Microwave Phased Arrays for Local Hyperthermia" in the July/August 1989 issue of the *International Journal of Hyperthermia, 5*, pp.429-450.

MEETINGS

EPRI Utility Seminars...EPRI will host a workshop on *Power-Frequency Electric and Magnetic Field Laboratory Research*, September 27-29, in Delavan, WI. Among the issues to be addressed are cancer research, neurobiology and behavior, developmental toxicology, whole animal and cell physiology, mechanisms of interaction and engineering factors.

Also scheduled is a panel discussion on EMF-related developments of the past year. Registration fees start at $175. For more information, contact: Robert S. Banks Associates, PO Box 14574, Minneapolis, MN 55414, (612) 623-4646.... EPRI is also sponsoring a course on *Measurement of Power System Magnetic Fields*, September 14-15, in Lenox, MA. The meeting is open to EPRI members only at a cost of $1,600. For more information, contact: Hazel Mazza, GE Co., High-Voltage Transmission Research Center, East New Lenox Rd., PO Box 796, Lenox, MA 01240, (413) 494-4359.

Ionospheric Effects...A call for papers has been issued for the *6th International Ionospheric Effects Symposium*, to be held in Washington, DC, May 1-3, 1990. The deadline for abstracts has been extended to September 15. The meeting is being sponsored by the Naval Research Lab, the Air Force Geophysics Lab, the Army Center for Command, Control and Communication Systems and the Office of Naval Research, among other branches of the DOD, and by the NTIA. The symposium will be unclassified. For more information, contact: Ionospheric Effects Symposium Coordinator, Code 4180, Naval Research Laboratory, Washington, DC 20375.

MILITARY SYSTEMS

HPM R&D... The Naval Air Development Center in Warminster, PA, has issued a request for proposals (RFP) for a study to identify the potential vulnerabilities of manned aircraft digital fly-by-wire control systems to high power microwaves (HPMs). The primary objectives of the study are: to develop a credible HPM threat profile—e.g., flux levels, frequencies and pulse durations; to identify probable HPM entry points, coupling paths, induced voltage/power/energy levels and consequent HPM effects; and to define hardening measures. The study does not call for any HPM testing; it will be limited to a review and an analysis of existing research. For more information on Solicitation N62269-89-R-0231, contact: John Stabilito, Purchase Service Branch, Code 84573, Naval Air Development Center, Warminster, PA 18974, (215) 441-2683....The Naval Research Laboratory (NRL) has issued a call for research on the effects of microwaves on electronics systems. For more information on Solicitation N00014-89-R-ET12, contact: Evelyn Taylor, Code 3240.ET, NRL, 4555 Overlook Ave., SW, Washington, DC 20375, (202) 767-6457....The U.S. Army Missile Command at the Redstone Arsenal in Alabama has awarded two contracts to Sparta, Inc., of Laguna Hill, CA, for work on a directed RF energy effects data base. The contracts are for a total of $195,000.

PEOPLE

Dr. **Lee Rosen** has left W/L Associates to join the NIH Division of Research Grants. After working with Dr. **Bill Wisecup** for nine-and-a-half years on power line issues, Rosen is now down the hall from Dr. **Elliot Postow**, who joined NIH from the Navy Medical R&D Command. Postow is the former editor of *Bioelectromagnetics*. Rosen told *Microwave News* that he hopes to be able to keep up with ELF health issues....Dr. **Richard Phillips**, another former editor of *Bioelectromagnetics*, will retire from EPA in September and plans to move back to the West Coast....After almost 33 years with AT&T Bell Labs' Radiation Protection Department, Dr. **Max Weiss** has retired. He will continue to serve on a number of state advisory groups, including the New Jersey Commission on Radiation Protection....The FDA has awarded Dr. **Przemyslaw Czerski** its Commendable Service Award for his "outstanding accomplishments in research" on the biological effects of EMFs and for his leadership in standard-setting activities. And Dr. **Zory Glaser** has been awarded the Public Health Service Commendation Medal for his work on radiological health and medical devices.

STANDARDS

NAB Opposes Seattle 100 μW Limit... The National Association of Broadcasters (NAB) is urging the city of Seattle, WA, not to adopt a proposed RF radiation standard that is ten times stricter than the ANSI standard—100 μW/cm² in the 30-300 MHz frequency band (see *MWN*, J/A88). The NAB argues that the proposed standard is "not supported by scientific data, is inordinately restrictive and would not benefit the public," and that "sound public policy should be based on established evidence, not superstition or fear of the unknown." The NAB was responding to a Draft Environmental Impact Statement (EIS) issued in May—a public hearing was held on May 30 in Seattle. The EIS, which covers a telecommunications policy and land use as well as the disputed RF ordinance, was prepared by the Seattle Office for Long-Range Planning. Under the proposed rules, the Department of Health would issue permits to broadcasters. According to the EIS, the department could grant a "special exception" under certain conditions, but levels could never exceed 200 μW/cm². The NAB again made its case for a national RF/MW exposure standard instead of the evolving "patchwork quilt" of local rules (see *MWN*, S/O85, M/A86, M/J86 and J/A88). For more information, contact: Cliff Marks, Office for Long-Range Planning, 200 Municipal Bldg., Seattle, WA 98104, (206) 684-8056.

EIA on TV/VCR Immunity...ANSI has published ANSI/EIA 544-1988, *Immunity of TV and VCR Tuners to Internally Generated Harmonic Interference from Signals in the Band 535 kHz to 30 MHz*. A copy is available for $13.00, prepaid, from: Sales Department, ANSI, 1430 Broadway, New York, NY 10018.

TECHNOLOGY

Zapping Hazardous Wastes... An efficient, cost-effective method for decontaminating soil full of toxic wastes using RF radiation has been developed by scientists at the IIT Research Institute (IITRI) in Chicago, IL. IITRI claims that the procedure, "RF *in situ* decontamination," has been demonstrated to be 99% effective in removing hazardous wastes and that it is

two-to-four times cheaper than traditional methods. The process, in which electrodes beam 2-45 MHz radiation into the contaminated soil, is "similar to the heating accomplished within a microwave oven, although the area heated is much larger and the frequencies are much lower," according to IIT-RI's Jack Bridges, one of the developers. "During the heating process, water and hazardous components in the soil are rapidly evaporated; the vapors are collected and condensed for subsequent removal from the site," he said. The remaining gases and liquids are reportedly one-thousandth of those produced by excavating and incinerating wastes. In a recent field test, approximately 30 tons of soil laced with jet fuel and chlorinated hydrocarbons were almost completely decontaminated, IITRI reports. The *in situ* method is an extension of an earlier IITRI technology—developed by Bridges and IITRI's Harsh Dev—using RF heat energy to extract fuels from oil shale and tar sand deposits. IITRI recently sold the commercial rights to its RF *in situ* process to Roy I. Weston, Inc., a West Chester, PA, company. A report describing the *in situ* process is available from: Dr. Glenn Paulson, Director, Center for Hazardous Waste Management, IITRI, 10 W. 35th St., Chicago, IL 60616, (312) 567-4250....On a related front, the April 10 *Wall Street Journal* reported on a procedure developed by the West German company Vetco Sanitec which uses microwaves to disinfect medical waste.

VDTs

Electric Allergies... In a recent study of 32 people "with alleged hypersensitivity to electricity," experts at the Department of Neuromedicine at the National Institute of Occupational Health (NIOH) in Stockholm, Sweden, found that most of the group attributed their problems to work at VDTs. But it is far from clear whether VDTs are responsible for all the cases. "We don't know what is causing the problem," NIOH's Dr. Kjell Hansson Mild told *Microwave News*. Using low-radiation VDTs did not improve the subjects' conditions—nor did eliminating "unnecessary" electrical appliances. "In some cases, there is a psychological component—and among those working with VDTs, stress and lack of ventilation may also be problems," Mild said. Nevertheless, he emphasized that electrical sensitivity is a real issue. Indeed, others in the U.S. and the U.K. have shown that weak EMFs can cause allergic reactions that are frequency specific (see *MWN*, M/A87 and J/A88). According to NIOH's Dr. Bengt Knave, the combination of VDT flicker and magnetic fields may explain why VDT workers report hypersensitivities more than other exposed groups, such as railway workers or welders. Mild said that since 1984, approximately 1,400 workers with dermatological problems have been referred to NIOH and about 10% of them have electrical sensitivities. But, he added, "That is just the tip of the iceberg." Mild said that a society has been formed in Sweden for those who suffer from these ailments.

ETC...

RF To Fight Terrorism?...A Washington state doctor suggests that there is a "simple solution" to guard against terrorist bombs aboard aircraft. In a letter to the June 7 *Wall Street Journal*, Dr. Jeffrey Reynolds advocates beaming RF energy at all baggage prior to takeoff to detonate any blasting caps that might trigger hidden explosives.

But Seriously, Folks... Standup Comic Billy Crystal to a packed Moscow audience in early August: "I wanted to perform in the U.S. embassy because it has the best microphones."

OTA Report on ELF Hazards *(continued from p.1)*

issue as a problem of field exposure rather than as a problem of high-voltage transmission lines."

The 103-page report, which was prepared for the OTA by Drs. Indira Nair, Granger Morgan and Keith Florig, all of Carnegie Mellon University's Department of Engineering and Public Policy in Pittsburgh, PA, provides detailed coverage of most of the major laboratory and epidemiological studies conducted over the past decade, as well as a section on risk assessment and policy alternatives.

Among the report's proposals is a strategy of "prudent avoidance": attempting to route new transmission lines so that they avoid people; widening transmission line rights-of-way; developing designs for distribution systems—including new grounding procedures—which would reduce the associated fields; and redesigning appliances to minimize or eliminate fields.

The report downplays the value of establishing regulatory standards with the rationale that, since the research appears to point to frequency window effects, setting a "safe" limit at this time cannot be scientifically supported and might potentially do "more harm than good."

In addition to calling for a balanced mixture of cell, whole animal and epidemiological studies, the report cautions against becoming too fixed on cancer as the "single health effect of concern."

The report has received widespread news coverage. For instance, the Associated Press story ran under the headline "Data on Electromagnetic Fields, Potential Risks Needed, Study Says" (*Arizona Daily Star*), while *USA Today* featured the report under the headline "Killer Toasters?"

Biological Effects of Power Frequency Electric and Magnetic Fields is available for $4.75 from: U.S. Government Printing Office, Superintendent of Documents, Washington, DC 20402, (202) 783-3238; specify stock number 052-003-01152-2. It serves as a background paper for another OTA report, *Electric Power Wheeling and Dealing: Technological Considerations for Increasing Competition.*

Cells exposed to microwaves alone did not respond. "You need a promoter like TPA to see the effect," Balcer-Kubiczek said in an interview in Tucson. "We are observing a synergistic effect of microwaves and TPA." She added that, "It is not clear whether the effect is caused by the microwave carrier frequency or by the ELF modulation. This is something we would like to follow up."

Last year, Dr. Abe Parola reported that 100 Hz sine waves could malignantly transform cells (see *MWN*, M/A88). Parola is at the Ben-Gurion University of the Negev in Beer-Sheva, Israel.

In a paper published earlier this year in *Radiation Research* (see references below), Balcer-Kubiczek and Harrison reported that microwaves can transform cells. They wrote, "In the experiments reported here, microwaves appear to act as an initiator in a two-stage transformation assay." They went on to note a "striking" similarity between their microwave findings and those of previous studies using ultraviolet radiation.

One point is clear, however: the cell transformation is not caused by heating. "It is important to note that any positive result from our *in vitro* microwave protocols cannot be explained by microwave hyperthermia because heat alone is known to be non-carcinogenic," the researchers point out. Also, they report that the measured temperature elevation in the microwave-exposed cell flasks did not exceed 0.3°C, and that the tumor promoter was added after microwave treatment.

The cell assay used by the Maryland researchers is very well characterized and widely used. It was originally developed for studying chemical carcinogens. "It predicts carcinogenic potential for chemicals with an accuracy of approximately 80%," Balcer-Kubiczek said.

The researchers have run the same experiment using various combinations of ionizing and non-ionizing electromagnetic radiation, as well as with ultrasound—with and without chemical promoters. In Tucson, they reported that continuous wave ultrasound does not cause cell transformation. They began their microwave experiments five years ago; they were originally supported by the Office of Naval Research and are now funded by the National Cancer Institute.

As early as 1981, Dr. Stanislaw Szmigielski of the Center for Radiobiology and Radioprotection in Warsaw, Poland, reported that non-thermal levels of microwaves could accelerate the development of tumors (see *MWN*, My81). Balcer-Kubiczek said that, "Our new results are not inconsistent with those of Szmigielski."

A major epidemiological study released by Szmigielski in 1985 showed that radiofrequency and microwave radiation had caused abnormally high rates of cancer among exposed servicemen; the preliminary results of an ongoing prospective epidemiological study support this finding (see box at left).

In a long-term exposure study carried out at the University of Washington in Seattle, rats exposed to relatively low levels of microwaves had a statistically significant increase in cancer, primarily of the endocrine system (see *MWN*, J/A84 and Mr85).

1. Note that the published papers cite an 83 μsec pulse width.

Papers by E.K. Balcer-Kubiczek and G.H. Harrison

"Search for Neoplastic Transformation *In Vitro* Following Pulsed 2.45 GHz Microwaves" and "Search for Neoplastic Transformation *In Vitro* Following Pulsed Ultrasound," presented at the *11th Annual Meeting of the Bioelectromagnetics Society*, Tucson, AZ, June 1989. The ultrasound results have just been published in the *Journal of Ultrasound in Medicine and Biology, 15*, pp.335-340, 1989.

"Induction of Neoplastic Transformation in C3H/10T½ Cells by 2.45 GHz Microwaves and Phorbol Ester," *Radiation Research, 117*, pp.531-537, 1989.

"Survival and Oncogenic Transformation of C3H/10T½ Cells After Extended X Irradiation," *Radiation Research, 104*, pp.214-223, 1985.

"Evidence for Microwave Carcinogenesis *In Vitro*," *Carcinogenesis, 6*, pp.859-864, 1985.

"Far-Field 2.45 GHz Irradiation System for Cellular Monolayers *In Vitro*," *Journal of Microwave Power, 20*, pp.145-151, 1985.

"Oncogenic Transformation of C3H/10T½ Cells by X-Rays, Fast-Fission Neutrons, and Cyclotron-Produced Neutrons," *International Journal of Radiation and Biology, 44*, pp.377-386, 1983.

Polish Epi Study Continues To Show RF/MW Cancer Link

An ongoing prospective epidemiological study of the Polish military continues to indicate that personnel exposed to radiofrequency and microwave (RF/MW) radiation have a higher than expected incidence of cancer.

In 1985, Dr. Stanislaw Szmigielski of the Center for Radiobiology and Radioprotection in Warsaw, Poland, announced that a major epidemiological study of military personnel showed a statistically significantly higher rate of cancer among servicemen exposed during 1971-1980, as compared to those unexposed (see *MWN*, Mr85). For blood-forming organs and lymphatic tissue, the rates were nearly seven times those expected.

Subsequently, a five-year (1986-1990) prospective epidemiological study was initiated to test the cancer hypothesis. In a recent letter to *Microwave News*, Szmigielski said that an analysis of the data collected after three years—at the end of 1988—"supports our earlier results from retrospective studies, although the differences between the exposed and non-exposed groups are somewhat smaller (although still highly statistically significant) than those found for the decade of 1971-1980." He wrote that the preliminary results indicate a doubling of the incidence of all forms of cancer among those exposed to RF/MW radiation (see also *MWN*, J/F87).