

MICRO WAVE NEWS

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A Report on Non-Ionizing Radiation

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EMPRESS II: Opposition Broadens

Three U.S. senators, the U.S. House Armed Services Committee, federal and Virginia environmental officials and the Maryland House of Delegates have joined others seeking to block the Navy's proposal to site its second electromagnetic pulse radiation environment simulator for ships (EMPRESS II) on Chesapeake Bay.

Three of the four U.S. senators from Maryland and Virginia are now publicly opposed to the Navy's plan for EMPRESS II. Maryland's Senators Paul Sarbanes and Barbara Mikulski, both Democrats, wrote to Navy Secretary John Lehman on March 16, urging him to "end any further consideration of testing...[EMPRESS II] in the Chesapeake Bay" and "to seek an alternative site."

"In our view, there are still too many unknown factors to guarantee that this untested program, designed to simulate effects of a nuclear explosion, will not have an adverse impact on the bay, our Chesapeake watermen who rely on these waters for their livelihood and the bay community," the Senators explained.

Virginia's Senator Paul Trible, a Republican, also wrote to Lehman to protest the Chesapeake Bay site, calling it "ill-conceived." In his March 26 letter, Trible noted that he is "particularly concerned about the effects high-voltage electromagnetic pulses will have on individuals who live near the bay. Significant dangers to human health exist."

Republican John Warner, Virginia's senior senator, has "reserved his opinion pending the Navy's reevaluation of the project," according to an aide.

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Lawsuit Over 345-kV Line in NY

In January, 55 landowners filed a suit for more than \$60 million against the New York Power Authority, claiming loss of property values due to the 345 kV Marcy-South power line. In a brief filed with the New York State Court of Claims in Goshen, the landowners allege that the line will create "a 'cancerphobia' corridor" and will destroy "the market value of land in and around that corridor."

The landowners are being represented by Michael Gurda of Gurda, Gurda & McBride in Middletown, NY. (The claims of all 55 plaintiffs have been consolidated into one trial.) Gurda told *Microwave News* that his clients are seeking a total right-of-way (ROW) of 2,400 feet around the 345 kV line to limit exposures to less than 0.5 milligauss.

The Power Authority is planning a 160-to-170-foot ROW, according to Michael Fiumarelli, the authority's manager for public affairs associated with transmission programs. In addition, there will be a 50-foot "danger zone" on each side of the ROW to protect

(continued on p.9)

WHO-IRPA Health Criteria: Static and ELF Magnetic Fields

An international committee of experts has concluded that there is an "urgent need" for studies to resolve the suspected link between very weak, extremely low frequency (ELF) magnetic fields and cancer.

In a report to be issued later this year, the experts, assembled by the World Health Organization (WHO) and the International Radiation Protection Association (IRPA), also state that short-term exposures to static fields below 2 Tesla (T) are not hazardous and that induced current densities of less than 10 mA/m² are "unlikely" to cause "adverse health effects."

The recommendations for human exposures to time-varying magnetic fields are not based on a cancer threat. At 50/60 Hz, a current density of 10 mA/m² is induced by a field of approximately 5 mT; the suggested carcinogenic effects of ELF magnetic fields occur at 0.1-1 uT (0.0001-0.001 mT) – levels more than a thousand times smaller.

In addition to urging more work on the possible ELF-cancer link, the WHO-IRPA experts recommend studies on the effects of time-varying fields on the developing embryo and fetus. They pinpoint interactions at the cell

membranes as worthy of special attention.

While acknowledging that studies have established that currents in the range of 10-100 mA/m² (from fields higher than 5-50 mT at 50/60 Hz) can cause bioeffects, the WHO-IRPA panel says that short-term exposures (a few hours) will cause only minor, transient effects on health. The consequences of long-term exposures to these levels "are not known at present," however. Above 100 mA/m² (greater than 50 mT at 50/60 Hz), the panel warns that "hazards to health may occur."

With respect to static fields, the committee concludes that "...available knowledge indicates the absence of any adverse effects on human health due to exposure to static magnetic fields up to 2 T." For exposure above 2 T, the panel says that it cannot "make any definitive statements about safety or hazard," but adds that short-term exposure in the range above 5 T "may produce significant detrimental effects on health."

(The WHO-IRPA panel notes that "it is difficult to correlate the internal tissue current densities with the external magnetic field strengths." The magnetic fields cited by the panel are therefore approximate and are

WHO-IRPA Conclusions

1. Only a few mechanisms of interaction of biological tissue with magnetic fields have been established. Some of the biological effects data suggest that other mechanisms may play a role, but these have yet to be confirmed experimentally. Thus, only a preliminary assessment of human health risk from exposure to magnetic fields can be made.

2. A number of lower organisms have shown a remarkable sensitivity to the earth's magnetic field, because of highly developed receptors. Similar receptors have not been found in human beings.

3. From the scientific data base on higher organisms exposed to magnetic fields, only four types of effect[s] can be regarded as established. The first three may be explained by plausible mechanisms of interaction and produce a basis for extrapolation to man. These effects are:

(a) induction of electrical potentials and magnetohydrodynamic effects within the circulatory system;

(b) the formation of magnetophosphenes with a time rate of change of magnetic field exceeding 0.3 T/s at 17 Hz; the effect depends strongly on frequency;

(c) direct stimulation of nerve and muscle cells by very short (less than 1 ms) pulses of rapidly changing magnetic fields (several thousand T/s). Current densities are estimated to exceed 1000 mA/m². These effects are strongly frequency dependent and may exhibit lower thresholds (100-1000 mA/m²) under more favourable stimulus conditions (10-100 Hz);

(d) other cellular and tissue alterations when the induced current densities exceed approximately 10 mA/m².

4. For human exposure to static magnetic fields, it is not possible to make any definitive statement about the safety or hazard associated with short- or long-term exposure to fields above 2 T. Available knowledge suggests the absence of any measurable effect of static fields on many major developmental, behavioural or physiological parameters in higher organisms. Recent medium-term (days) studies on exposure of animals to static fields of up to 2 T have not demonstrated any detrimental effects.

5. For human exposure to time-varying magnetic fields, it seems reasonable to assume that a health risk assessment can be made on the basis of significant perturbations of biological functions caused by electric currents induced by the fields. Available data suggest that, when current densities less than 10 mA/m² are induced in tissues and extracellular fluids, the induction of adverse health effects is unlikely. However, the possibility of some perturbing effects occurring following long-term exposure cannot be excluded.

The time-varying fields that induce currents in the body depend critically on the waveform and pulse shape. In this regard, the peak instantaneous current densities appear to be important. Furthermore, the frequency dependence of effects produced by time-varying fields has to be taken into consideration.

generally accurate within a factor of ten.)

Environmental Health Criteria 69: Magnetic Fields was written over a number of years. A first draft prepared by Dr. Michael Repacholi was revised in May 1985 by a committee chaired by Dr. P. Czerski (see *MWN*, May 1985). The final draft was reviewed in Kiev, U.S.S.R. last summer.

In 1984, a previous WHO-IRPA committee issued a report on the health effects of ELF fields, primarily electric fields (*Environmental Health Criteria 35*). That committee, which was made up of many of the same experts, recommended that, given the uncertainties in the data base, efforts should be made to limit long-term exposures of the general population to "levels as low as can be reasonably achieved" (see *MWN*, December 1984).

According to Czerski, who is at the Food and Drug Administration's Center for Devices and Radiological Health in Rockville, MD, the WHO-IRPA report is in press and should be available by the end of the year from WHO regional offices. In the U.S., contact the WHO Publications Center USA, 49 Sheridan Ave., Albany, NY 12210. Elsewhere, contact the WHO Sales and Distribution Service, 1211 Geneva 27, Switzerland.

The members of the WHO-IRPA task group which met in Kiev are: Drs. V. Akimenko (U.S.S.R.), B.G. Bernardo (The Philippines), J. Bernhardt (F.R.G.), B. Bosnjakovic (The Netherlands), J. Dumansky (U.S.S.R.), M. Grandolfo (Italy), H. Jammet (France; co-chairman), Y.A. Kholodov (U.S.S.R.), B. Knave (Sweden), S. Mohanna (Canada), M.H. Repacholi (Australia; rapporteur), R.D. Saunders (U.K.), M.G. Shandala (U.S.S.R.; co-chairman), Ing. J. Skvarca (Argentina), D. Sliney (U.S.), T.S. Tenforde (U.S.). Annette Duchene served as the scientific secretary for the group.

The full text of the WHO-IRPA committee's conclusions is reprinted on the opposite page.

EPA-FCC Surveys Find More RF Hot Spots

Broadcast transmission towers serving Portland, OR, and Denver, CO, are producing radiofrequency (RF) hot spots in publicly accessible areas, according to surveys by the Environmental Protection Agency (EPA) and the Federal Communications Commission (FCC). In both surveys, FM radio transmissions contributed the most to ambient RF fields.

Near one tower in the Denver area, radiation levels were more than ten times greater than the American National Standards Institute's 1 mW/cm² guideline – used by the FCC to evaluate environmental impacts – prompting the EPA to urge the FCC to take corrective action.

Inside homes near the towers, typical levels were below 100 uW/cm² in Denver and below 70 uW/cm² in

Portland.

EPA's Richard Tell and the FCC's Dr. Robert Cleveland made the measurements last year in response to public concerns over the health effects of RF radiation. The two surveys followed those carried out in Honolulu, HI and Cougar Mountain, WA (see *MWN*, January/February 1985 and January/February 1986, respectively). The Portland and Denver reports were written by EPA.

Healy Heights, Portland

In Portland, the EPA-FCC team measured fields at several locations near two broadcast towers – one with six FM stations and one with one FM and one AM station – on Healy Heights, as well as in surrounding neighborhoods, from July 28 to August 1, 1986. In addition, readings were taken near two AM radio towers in non-residential areas.

Outdoors, the maximum level identified was less than 700 uW/cm² near the base of one of the towers; the team measured a 500 uW/cm² field in a nearby publicly accessible area. EPA reports that "large areas exist where levels in excess of 100 uW/cm² can be found."

The EPA-FCC measurements were made before and after one of the FM stations, KBOO, installed a new antenna and raised it on the tower. Before the change, the maximum level at the base of the tower exceeded 1 mW/cm².

On Healy Heights, the maximum indoor level approached 200 uW/cm² in one residence close to the two towers, but in a housing development a little further away, typical indoor levels were below 40 uW/cm², though a maximum reading of 117 uW/cm² was found.

Radiation levels were much lower in neighborhoods further away from the antenna farm – generally less than 1 uW/cm².

In its report to the FCC, EPA also notes that:

- Magnetic fields near the tower bases and tuning coils of AM antennas at two towers were far in excess of the FCC-ANSI limit of 1.6 A/m – over 10 A/m in many locations. The electric field levels were below the ANSI limit of 632 V/m. These antennas were not in residential areas; EPA cautions that broadcast engineers should take care to avoid overexposure.
- Measured levels differed from calculated values. For FM readings beyond 22 meters from the tower, the readings exceeded those predicted by a computer program. The reasons for this are not clear, though the EPA report suggests the discrepancy may be related to reflections from the antenna farm. Conversely, AM readings were below those derived from worst-case models specified in FCC OST Bulletin No.65 (see *MWN*, September/October 1985).
- "Electric field values high enough to interfere with the normal operation of electronic devices were found in several of the areas surveyed," according to the report.

HIGHLIGHTS

Multnomah County, in which Portland is located, has a general population exposure standard of 200 $\mu\text{W}/\text{cm}^2$ (see *MWN*, May and July/August 1982). The city of Portland is in the process of setting its own standard; the current proposal is 200 $\mu\text{W}/\text{cm}^2$, though previously the city's planning department had recommended a 100 $\mu\text{W}/\text{cm}^2$ exposure limit (see *MWN*, July/August 1985, November/December 1985 and March/April 1986).

Lookout Mountain, Denver

The EPA-FCC team found even higher RF levels in the Denver area during its September 1986 survey.

Tell and Cleveland measured a 10.35 mW/cm^2 hot spot near the base of an FM radio tower (KYGO) and power densities above 1 mW/cm^2 over a large nearby area, "most of which is publicly accessible," according to the report. The KYGO tower is about one-third of a mile from the main antenna farm on Lookout Mountain.

In its report, EPA urges "the FCC to order KYGO to correct these extreme values in publicly accessible areas as soon as possible."

The KYGO tower sits among a complex of buildings, including some residential facilities. In the main building, about 100 feet from the tower, the team "found maximum power densities of 59 $\mu\text{W}/\text{cm}^2$ in the laundry room, approximately 100 $\mu\text{W}/\text{cm}^2$ in the commissary and

outside the dining hall and up to 300 $\mu\text{W}/\text{cm}^2$ on the patio/deck." Outside a dormitory, levels of 40-50 $\mu\text{W}/\text{cm}^2$ were measured.

Several of the broadcast towers on Lookout Mountain are also in residential areas, but levels measured there, both indoors and outdoors, were less than those near the KYGO tower. The maximum outdoor level was 580 $\mu\text{W}/\text{cm}^2$. Typical averaged indoor field levels at residences were well below 100 $\mu\text{W}/\text{cm}^2$ and most were less than 50 $\mu\text{W}/\text{cm}^2$. Two high readings in the nearby residential neighborhood – 200 and 589 $\mu\text{W}/\text{cm}^2$ – apparently resulted from measurements taken near metal objects. The measured power levels dropped off dramatically with distance from the antenna farm.

On one stretch of road between two towers which are less than a mile from the Lookout Mountain antenna farm, Tell and Cleveland found a maximum power density of 425 $\mu\text{W}/\text{cm}^2$ and levels above 200 $\mu\text{W}/\text{cm}^2$ along a 125-foot stretch of public road.

The two reports, *An Investigation of Radiofrequency Radiation Levels on Healy Heights, Portland, OR, July 28-August 1, 1986* (January 1987) and *An Investigation of Radiofrequency Radiation Levels on Lookout Mountain, Jefferson County, CO, September 22-26, 1986* (February 1987), are available from the FCC's duplicating contractor, International Transcription Services, 2100 M St., NW, Washington, DC 20037, (202) 857-3800.

Sine Waves Gain Acceptance for Electrical Stimulation

Sine waves are challenging more complex quasi-rectangular, asymmetric waveforms in the treatment of non-union fractures. Government approval of a medical device using sine waves comes at the same time as laboratory studies showing that sine waves can be as biologically active as complicated signals, if not more so. The acceptance of non-thermal effects due to sine waves has obvious implications for the health assessment of all electromagnetic devices.

Researchers and clinicians in the Departments of Bioengineering and Orthopaedic Surgery at the University of Pennsylvania in Philadelphia developed a sine wave generator operating at 60 kHz to electrically stimulate bone growth. Working with Bioelectron, Inc., of Hackensack, NJ, they successfully tested the new medical device, OrthoPak®, in a 16-center trial and won approval from the Food and Drug Administration (FDA) in February 1986 (see *Federal Register*, 51, pp. 12210-12211, April 9, 1986).

When Bioelectron originally approached the University of Pennsylvania team to develop OrthoPak, the New Jersey company favored a complex waveform. Since no

one could explain *why* a complex signal might be more effective, said University of Pennsylvania Professor Solomon Pollack, "we decided to start with a signal whose frequency composition was something we *could* understand – the sine wave."

On the basis of dose-response studies using a rat model already developed by the Pennsylvania team, including Professors Carl Brighton and Jonathan Black, they soon found that a 60 kHz sine wave could stimulate bone growth. Now that the initial research is complete and OrthoPak is being marketed by Zimmer, Inc., of Warsaw, IN, the group plans to focus more energy on learning how the sine waves actually do their work.

The University of Pennsylvania clinical studies support the experimental research of Drs. Reba Goodman of Columbia University and Ann Henderson of Hunter College, both in New York City, who have shown that sine waves enhance cellular transcription in salivary gland cells of larval flies as readily as do more complex, asymmetric waves (see *MWN*, September/October 1985 and November/December 1986 and *Bioelectromagnetics*, 7, pp. 23-29, 1986, and 8, pp. 1-7, 1987).

Others are also developing sine wave medical systems. Dr. Ewa Herbst, a Swedish researcher visiting Dr. Betty Siskin's lab at the University of Kentucky in Lexington, will present a paper at the June Bioelectromagnetics Society meeting in Portland, OR, on the efficacy of 72 Hz sine waves in healing soft tissues in rats.

Electro-Biology, Inc. (EBI), and American Medical Electronics (AME) market competing devices for treatment of non-union fractures: both use a complex signal delivered in repetitive pulses. To date, EBI is the market leader, but, according to Pollack, Bioelectron has already sold thousands of stimulators.

EBI is not fazed by the competition. Indeed, it welcomes the entry of OrthoPak into the market. Dr. Brian Pethica, an EBI corporate vice-president, told *Microwave News* that the unit is "broadly good for the industry and the field because it comes from a well-researched background."

All three devices "seem to be about as successful on a statistical basis, although there have never been any direct comparative studies," University of Pennsylvania's Black said in a telephone interview. "And, to me, that alone seems to undercut the argument for signal specificity, because the kinds of signals that these three systems produce at the non-union site are quite different."

Dr. Andrew Bassett, whose early work was the basis for the EBI signal, takes a different view. While acknowledging that the OrthoPak system works, he argued that "it may effect healing by a different mechanism that may or may not be as efficient as the EBI signal." Bassett is now the director of the Bioelectric Research Center in Riverdale, NY.

Commenting on the implications of government acceptance of sine wave-based medical technology, Louisiana State University Professor Andy Marino, the editor of the *Journal of Bioelectricity*, said in a telephone interview that, "The FDA has crossed the Rubicon in recognizing the existence of non-thermal effects, unencumbered by speculation about the unique properties of particular waveforms."

OrthoPak's sine wave technology offers at least one clear advantage over its competitors – portability. OrthoPak is a "capacitive" system, generating an electric field at the stimulation site. The EBI and AME devices are "inductive," using a primarily magnetic field to accelerate bone repair. As a result, "the power requirements for the two systems are grossly different," Pollack explained. The inductive devices depend on a rechargeable nickel-cadmium battery pack weighing several pounds. OrthoPak, which runs on a nine-volt battery, weighs only five ounces and can be mounted on a cast or a belt clip. In many cases, its compact size allows the fracture patient complete mobility.

Encouraged by this success, the University of Pennsylvania researchers now are trying to harness sine waves to treat two common ailments: osteoporosis and

EBI Turns to Clinical Research

Electro-Biology, Inc. (EBI), the first and most successful company to exploit electromagnetic fields (EMFs) for medical purposes, is shifting its research focus from laboratory to clinical studies. The move comes at a time when government agencies have cut back, or eliminated, their research efforts on the bioeffects of EMFs.

"We are placing increased emphasis on the exploitation of research that has already been done," Dr. Brian Pethica told *Microwave News* in a telephone interview from EBI's offices in Parsippany, NJ. Pethica, a corporate vice-president, refused to divulge specific details on EBI's research budgets – arguing these are privileged – but did acknowledge that the company is "shifting emphasis" in an effort to expand its product base. Bringing new products to market is "non-trivial," he said.

In a series of interviews, scientists who are struggling to keep their labs open, bemoaned the EBI move. Many questioned how a high-tech company that pioneered the use of EMFs could pull back from research when basic mechanisms of interaction remain largely unknown.

"The future of the whole field rises and falls on the ability to define mechanisms of action," one leading researcher, who asked for anonymity, said. "This is not the time to stop funding basic research."

Dr. Joan Abbott, EBI's director of research, said that, in the past, the company spent an "enormous amount of money without controlling the quality of the science." EBI is now focusing its efforts more carefully, she added.

Neither Pethica nor Abbott would say whether EBI's total research budget – for both clinical and lab studies – has gone up or down. Pethica did note that EBI is continuing to fund basic research in Europe.

EBI recently moved its offices and closed its in-house lab. Pethica and Abbott said that running a small independent lab was inefficient. "We felt we could get more mileage out of external research institutions," Abbott said. According to Pethica, EBI had only one doctoral-level scientist in the lab working primarily on screening studies.

degenerative joint disease. They have completed one study of disuse osteoporosis in rats, "with outstanding success," according to Pollack. This summer they will complete a study of systemic osteoporosis using another rat model. The FDA has given approval for pilot studies in humans, but large-scale human studies have not yet been scheduled. Definitive experiments on degenerative joint disease – the form of arthritis that commonly develops in the elderly – are still on the drawing board.

Allergies to Electromagnetic Fields

Weak electromagnetic fields (EMFs) can cause allergic reactions, including convulsions, fatigue, hyperactivity and migraines, according to clinical studies by three British researchers. Laboratory experiments have shown that these sensitivities are frequency specific and can occur at extremely low intensities.

Drs. Jean Monro and Ray Choy of the Allergy and Environmental Medicine Unit at Lister Hospital in London and Dr. Cyril Smith of the Department of Electronic and Electrical Engineering at the University of Salford (near Manchester) examined individuals with multiple allergies who reacted to various types of electrical equipment, including power lines, electric typewriters, video display terminals (VDTs), hair dryers and fluorescent lights.

In an interview, Smith told *Microwave News* that by ignoring the health impacts of EMFs, "people have been looking at the world with one eye closed, seeing only chemistry with the other."

A number of the researchers' extremely sensitive patients responded to specific, weak signals even when exposed to much larger background levels at power line frequencies usually found inside buildings. In a recent paper published in *Clinical Ecology*, they point out that, "The important factor in all these electrically sensitive patients appears to be the frequency; the signal strength is of secondary importance once a critical signal strength [which can be as low as 1 mV/m] is exceeded."

The researchers have examined over 100 patients with similar allergic reactions to EMFs in London, England, and in Dallas, Texas. More recently, they exposed a number of the subjects to incremental changes in frequencies ranging from millihertz to gigahertz. While some allergic patients reacted to the signals within 15 seconds, others did not respond until later – not an uncommon phenomenon, according to Smith.

Among the patients' symptoms were:

- Extreme glandular pain and speech problems when passing underneath high-voltage power lines, and migraines and fatigue when using electric irons or toasters in humid weather or during the approach of a storm.
- Hyperactivity and severe headaches in the presence of electric light bulbs, fluorescent tubes, computer games and televisions.
- Severe headaches near VDTs and breathing problems and fainting near high-power TV transmitters.

• The most sensitive patient – allergic to EMFs ranging from less than 1 Hz up to 2 GHz and to a wide range of chemicals – had convulsions when taken to within 200 meters of a power line while she was in an

allergically sensitive condition. On the return trip, she experienced a similar reaction when her ambulance passed under other power lines.

Monro, Choy and Smith suggest that electrical reactions are the basis for most allergies. They believe that EMFs and chemical allergens are related: an allergy triggered by one can be neutralized by the other, and vice versa.

According to Smith, if people's responses to EMFs are statistically similar to the incidences of chemical and nutritional allergies, then approximately one person in a thousand is affected by EMFs.

Smith points out that homeopathic medicine has long recognized the importance of EMFs: "Samuel Hahnemann, the founder of homeopathy, wrote 150 years ago about the therapeutic effects of electromagnetic fields."

Among the group's recent papers are: Smith, "Clinical Effects at High Dilutions," *Proceedings of the 42nd Congress of the International Homeopathic Medical League*, March 29-April 2, 1987, Arlington, VA, pp. 272-281; Choy, Monro and Smith, "Electrical Sensitivities in Allergy Patients," *Clinical Ecology*, 4, pp. 93-102, 1987 (the journal is published by Dr. Lawrence Dickey in Fort Collins, CO); Smith and A.H. Jafary-Asl, "The Emission of Low Intensity Electromagnetic Radiation from Multiple Allergy Patients and Other Biological Systems," presented at the *International Symposium on Photon Emission from Biological Systems*, January 1986, Wroclaw, Poland; Smith, "Water – Friend or Foe?," *Laboratory Practice*, October 1985; Smith, "Electromagnetic Phenomena in Living Biomedical Systems," *Proceedings of the 6th Annual Conference of the IEEE Engineering in Medicine and Biology Society*, September 15-17, 1984. See also: Cynthia Kee, "The Waves We Live In," *The Observer* (London), March 8, 1987; Simon Best, "Laying It on the Power Line," *Guardian* (London), October 24, 1984.

For more information, contact: Dr. Jean Monro, Allergy and Environmental Medicine Unit, Lister Hospital, Chelsea Bridge Rd., London SW1W 8RH, U.K.; Dr. Cyril Smith, Department of Electronic and Electrical Engineering, University of Salford, Salford M5 4WT, U.K.

The British researchers are collaborating with Dr. William Rea, Environmental Health Center, Suite 205, 8345 Walnut Hill Lane, Dallas, TX 75231, (214) 368-4132. Rea presented a paper on "Environmental Sensitivities" at the *5th Annual International Symposium on Man and His Environment in Health and Disease*, held in Dallas, TX, in February 1987.

Florida Power Line Standards Due Out Soon

The Florida Department of Environmental Regulation (DER) plans to propose exposure standards for extremely low frequency (ELF) fields in May, according to DER's Buck Oven, who is coordinating the development of the state's power line siting rules.

Oven told *Microwave News* that DER will propose standards for electric and magnetic fields, as well as for audible noise. Although Oven would not be very specific, he did say that the electric field exposure limit will be "in the same ballpark as existing state standards – in the 1-3 kV/m range." He would not reveal what the magnetic field proposal will be, but predicted that the audible noise standard will probably be the limiting variable; that is, by satisfying the audible noise limit, the other two standards will also be met.

In the telephone interview, Oven detailed the following schedule: DER officials are in the process of preparing a summary report, including recommendations, to present to the state's Electric and Magnetic Field Advisory Panel before the end of April. In May, the proposed rules will be released for review, to be followed by workshops and public hearings. In August, DER will submit final rules to the state's Environmental Regulation Commission – they would then be presented for adoption by the Florida Secretary of State.

The siting of power lines in Florida is at a standstill pending the completion of this rulemaking process (see *MWN*, July/August 1983, September/October 1985 and March/April 1986).

Advisory Panel Meetings

At a briefing on March 20, the advisory panel heard presentations from Drs. Dan Bracken, Philip Cole, Morton Miller, Granger Morgan, Jerry Phillips, Asher Shepard and Karl Smith, as well as from Pierce Wood of Tampa Electric Co. At its December 12 meeting the panel heard from Drs. David Savitz and Nancy Wertheimer.

DER also commissioned an evaluation of epidemiological studies related to power line fields by Dr. Paul Leaverton, the chairman of the University of South Florida School of Public Health's Department of Epidemiology and Biostatistics. In his February 5 report, Leaverton said that "the consensus among epidemiologists conducting a similar review would conclude that the hypothesis that 'long-term exposure to low-frequency electromagnetic fields is hazardous to one's health' is still an open question." He recommends more case-controlled studies, with sufficient sample sizes to "achieve reasonable statistical power."

Meanwhile, in December, the chairman of the panel,

Dr. Lloyd Beidler of Florida State University, resigned and was replaced by Dr. John Parker of Florida International University. In his letter of resignation, Beidler stated that the new governor and the head of DER would want to appoint their own chairman because "the ultimate policy related to [electromagnetic field] concerns will be a result of political as well as scientific decisions."

Sources told *Microwave News* that, in fact, Beidler was asked to stay on by Governor Robert Martinez's incoming administration, but that Beidler decided to resign anyway out of possible concern over litigation which may arise from the panel's recommendations.

For more information, contact: Buck Oven, DER, 2600 Blair Stone Rd., Tallahassee, FL 32301, (904) 487-2522.

Leeper To Market Meter

Ed Leeper will soon begin producing a hand-held meter to measure power line magnetic fields. Available in May, the meter will cost \$225.00 – substantially less than currently available measuring devices.

In a telephone interview, Leeper told *Microwave News* that he designed the unit – the AC Milligaussmeter – to "provide a means by which one can track down and quantify field sources." He added that his meter "should make it easier to determine which types of power lines are the important field producers in a given locale."

For many years Leeper, a physicist, has collaborated with Dr. Nancy Wertheimer on epidemiological studies on the link between power line electromagnetic fields and cancer (see *MWN*, March 1983 and November/December 1986).

The AC Milligaussmeter measures magnetic fields down to 0.1 milligauss (mG) and has a flat response between 40 Hz and 1 kHz with an accuracy of $\pm 5\%$, according to Leeper. It has 12 scales, from 0.5 mG to 2.5 G full-scale. The unit displays true rms values and has a sharp low-frequency cut-off, which filters out the spurious signals produced by movements of the hand-held coil in the Earth's magnetic field – an innovation which allows the measurement of low-intensity fields with the hand-held probe, Leeper said. The meter also has an audio output to help to identify maximum field levels.

Leeper's new unit provides an alternative to using the "Deno Meter" – designed and built by Dr. Don Deno of GE – which costs \$1,200 but which also measures a number of other variables, including electric fields, current and space potential.

For more information, contact: Ed Leeper, Monitor Industries, Salina Star Route, Boulder, CO 80302, (303) 442-3773.

The Savitz Cancer Study: The Repercussions

Outlined below are some of the developments that have followed the release of Dr. David Savitz's epidemiological study linking power line magnetic fields with childhood cancer (see *MWN*, November/December 1986).

More Data Analysis

The New York State Power Line Project, which sponsored the study, has given Savitz additional funds to do more data analysis. In a telephone interview, Savitz said that he will investigate whether "the wire coding relationship holds up after adjustment for traffic density."

In addition, Savitz plans to look at people's exposure histories in greater detail. That is, he will try to determine how long subjects lived in the homes they were occupying at the time of the study.

Savitz said that he is going to wait until he has finished the analyses before submitting a paper for publication. He predicted that he will be finished by the early fall.

Reports To Be Available Soon

Savitz's final report to New York State will be available soon from the project office in Albany. The total cost of the report was not known at press time; it will be \$0.25 per page.

The report on the epidemiological study of adult leukemia risks by Battelle's Dr. Richard Stevens will be available from the project office by the end of April. Stevens's final report will include Bill Kaune's *Residential Magnetic and Electric Fields Measured over 24-H Periods*, which is in itself over 100 pages long.

For more information on obtaining the Savitz, Stevens or any other New York project reports, contact: Charlene McAuliffe, Power Line Project, Department of Health, Room E-297, Empire State Plaza, Albany, NY 12201, (518) 474-7888.

(Note that Savitz and Dr. Eugenia Calle's review of epidemiological surveys of workers exposed to electromagnetic fields, which was reported in the May/June 1986 issue of *Microwave News*, has been published: see *Journal of Occupational Medicine*, 29, pp. 47-51, January 1987.)

DOE and EPRI Workshops

Immediately following the November power line meeting in Denver, CO, the Department of Energy (DOE) sponsored a workshop on epidemiology and cancer. A report on that meeting, *Epidemiologic Studies on Electromagnetic Fields and Cancer in Humans*, has been completed. A panel of experts recommended that:

- A meeting of agency representatives involved in research funding should be held to determine whether present overall programmatic directions should be reconsidered and to explore possibilities of cooperative ventures to finance the recommended studies.
- A major concern for [DOE's Office of Energy Storage and Distribution] in the near term should be in ascertaining appropriate in vitro studies and animal models to be used in long-term studies (e.g., carcinogen assays) of ELF field effects.

Although widely circulated, the report has not been released to the public.

The Electric Power Research Institute (EPRI) held its own workshop to set research priorities on January 29-30. The recommendations of the experts assembled by EPRI, reprinted on pp. 9-12, have not been released to the public, either.

In the News

In our last issue, we quoted EPRI's Dr. Leonard Sagan as saying that it was only a matter of time before the press would report the findings of the association between power line fields and cancer.

He was right. Since Savitz released his results in November, a number of national magazines have run stories on the health impacts of power lines:

- Jeff Hecht's "Electricity Blamed for Childhood Cancers" appeared in the January 15 issue of the *New Scientist*.
- *Science News* ran Diane Edwards's "Power Line Peril?" as the cover story in its February 14 issue.
- The March 30 *U.S. News & World Report* devoted three pages to Stanley Wellborn's "An Electrifying New Hazard," including a color picture of Dr. Nancy Wertheimer and Ed Leeper.
- *Hippocrates*, a new magazine on health and medicine based in Sausalito, CA, featured an item on the Savitz study in the "Vital Signs" news section of its premier issue (May/June).

Sources told *Microwave News* that the *EPRI Journal* has prepared an article on the power line health question, but that senior management has not yet approved its publication.

Judging by the letters to the editors printed to date in response to these articles, the public reaction has been somewhat skeptical. Philip Lunnon of British Gas in London told the *New Scientist* (February 26) that he thinks researchers should look into the possibility that "birdshit" may be the agent causing the increase in cancer.

On a more serious note, Dr. H.W. Lewis, a physics professor at the University of California, Santa Barbara,

wrote to *Science News* (March 28) that the cancer-ELF link is not plausible: "One induces comparable electric fields in the body by walking through the Earth's fields at a speed a good deal less than 1 m.p.h., and children are faster than that." In contrast, Biology Professor Martin Sage of the University of Missouri in St. Louis cited Swedish and Russian studies showing that ELF fields can have biological effects.

Interestingly, the major U.S. newspapers have not picked up the story.

Australian Line May Be Delayed

In Australia, where a controversy is raging over a 220 kV line in the state of Victoria (see *MWN*, July/August 1986 and January/February 1987), the Savitz study has received a great deal of play – even more so after Professor Bruce Armstrong, the director of the National Health and Medical Research Council's Epidemiology and Preventive Medicine Research Unit, issued a report saying that the epidemiological data, though not conclusive, "cannot be dismissed as explicable by chance, bias or confounding."

As a result, there is a possibility that the 220 kV line may be delayed for three months, pending further health analyses.

FROM THE FIELD

EPRI's Proposed ELF Research Projects

On January 29-30, the Electric Power Research Institute (EPRI) convened a group of experts in San Diego, CA, to set research priorities for studies on the bioeffects, especially carcinogenesis, of power line electromagnetic fields. Reprinted below are their recommendations for future work in seven research areas. These grew out of discussions at the workshop and were later written up by the panel chairmen. The chairmen, and their specialties, are: Dr. John Peters of the University of Southern California, on epidemiology; Dan Bracken, a consultant, on exposure assessment; Dr. Neil Chernoff of the Environmental Protection Agency and Dr. Frank Welsch of the Chemical Industry Institute of Toxicology, on teratology; Jack Lee of the Bonneville Power Administration and Dr. William Bailey of ERI, Inc., on DC fields; Dr. Marvin Goldman of the Energy-Related Health Research Lab at the University of California, Davis, on animal carcinogenesis; Dr. Granger Morgan of Carnegie Mellon University, on risk assessment; and Dr. Tom Tenforde of the Lawrence Berkeley Lab, on mechanisms of interaction. Dr. H.B. Graves, who chaired the San Diego review, is in the process of polling those who attended as to which of the projects detailed below should have the highest priority for funding.

EPIDEMIOLOGY RESEARCH PROJECTS

...It was stressed at the meeting several times...that human studies are inseparable from exposure assessment and both must be planned and conducted concordantly....

Children's Cancer: Certainly from both a political and

NY Power Line (continued from p.1)

against falling trees. The Marcy-South line will be 206 miles long, running from Marcy to East Fishkill; half of the line has already been completed.

The approval of the 765 kV Marcy-North line in 1978 followed a protracted battle. One result was the setting up of the New York State Power Line Project. The Marcy-South line has also been opposed by citizen groups along the line, but past suits have been dismissed.

Gurda plans to stress the cancer risk from the power line fields. Among the expert witnesses scheduled to testify for the plaintiffs are: Drs. Robert Becker, Harris Busch, Marvin Chatkoff, Andrew Marino, Jerry Phillips and Nancy Wertheimer. Many of these experts also testified in the Houston Lighting & Power Co. trial in Texas that resulted in a \$25 million award for punitive damages; that decision is under appeal (see *MWN*, November/December 1985 and November/December 1986).

No court date has yet been set, but Gurda predicted that the trial will start next fall or early winter.

In Florida, two landowners have won large awards after alleging losses associated with property adjacent to a 500 kV line. Florida Power & Light Co. has appealed those decisions to the state's Supreme Court (see *MWN*, September/October 1986).

public health point of view, ascertaining whether electromagnetic fields (EMFs) can cause childhood cancer is an extremely important line of research. The strongest evidence points at leukemia as the major outcome of interest, but there is also evidence that brain cancer, and perhaps, other cancer sites are similarly at risk. The biggest defect in our current knowledge is an understanding of lifetime exposure even though attempts at semi-quantitative exposure assessment have provided data to support the concern. Extension of our existing knowledge will rest on better assessment of residential and public exposure encountered by children. Improved exposure assessment will provide either firmer evidence for risk or firmer evidence for lack of risk. It also seems important, at least for the time being, to focus on specific cancer sites as specificity both in the sense of diagnosis and in the sense of exposure assessment enhances our opportunity to prove hypotheses.

In more specific terms, two types of studies seem in order. The first is a more careful look at residential exposures with 24-hour measurements of EMFs and estimates of exposure based on appliance use. Likewise, estimates of exposure from schools, daycare centers, playgrounds, etc. should enter the exposure assessment effort. Following this, and depending to some extent on the outcome of the first study, a large megachild study covering a significant part of the U.S. should be considered. The Children's Cancer Study Group provides such an opportunity as there is a consortium of hospitals covering a large segment of the U.S., collaborating in case finding related to childhood cancers.

Occupational Studies: There are two primary questions that need to be answered in this area. One is whether the electrical workers identified in the published associations between leukemia and electrical work really do have exposure to higher levels of EMFs than other occupations. And the second important question is whether populations with proven high exposure for long duration really have an excess of leukemia or other cancers. Ideally, at least six conditions should be met for the latter study: (1) The population must be large enough for the study to have adequate statistical power to have a high probability of detecting an association between leukemia and EMF exposure, if one exists; (2) it must contain a significant proportion of workers exposed to EMFs considerably above background; (3) it must contain a significant portion of workers with long-term exposure; (4) written records regarding job assignments of study subjects must be available; (5) it must be feasible to measure EMF exposures of present day jobs and to infer past exposure from these measurements. This implies that the exposure in any specific job must have remained constant or be predictable, based on the job duties and location; and (6) there must be a way of identifying cases of leukemia or other cancer either through population-based disease registries or through company records (medical, insurance, etc.). It must be emphasized that any studies of occupational groups must include a strong effort to identify concomitant carcinogenic exposures, for example, solvents and PCBs.

Opportunistic Epidemiology: Efforts should be made to identify populations with higher than average exposures to EMFs. Examples of this might include electric blankets or resistance ceiling heating. If it is true that very high electric (E) and magnetic (B) fields are found under electric blankets and if high EMFs cause leukemia or other cancer, then electric blanket users should be at risk of leukemia or other cancers. This question could easily be added to existing questionnaires of case-control studies of adult leukemia, and there is no reason to think that objective reproducible information would not be forthcoming.

Life Exposures: This category probably belongs more to the exposure assessment consideration, but nonetheless the human studies are impaired by our general lack of knowledge on ambient EMF exposures encountered in various living activities. A greater knowledge of these exposures would probably result in some hypotheses that could be tested through population studies.

Costs and Time: A good study of children's cancer, particularly leukemia, taking a careful look at residential and public exposures would probably take about three years to complete and would cost approximately somewhere between \$750,000 and \$1,000,000. In the occupational studies, characterizing the exposure of electrical workers versus non-electrical workers would take between one and two years, and would cost approximately \$250,000. The study of high exposure/long duration employees in a cohort followed by a case-control study would probably take about five years and would cost in the low millions. The opportunistic epidemiology, if attached to ongoing or planned case-control studies, would have a relatively small cost, certainly under \$50,000, and would take the same amount of time to complete as the parent study. Life exposures could be studied forever. If answers are provided by the other studies that either incriminate or reduce the chance of there being a risk, then the need for such studies might be increased or decreased.

EXPOSURE ASSESSMENT PROJECTS

Occupational: •Collect occupational exposure data for 60 Hz E- and B-fields. There should be sufficient data to produce various exposure metrics. Ultimately, this will be a long-term effort with large N. Other exposure parameters should be included. Exposure from power lines should be differentiated from that due to other sources. All industry sectors should be sampled including the rapidly expanding service industries, medical services and industries using pulsed fields. The protocols and exposure data should be compatible with efforts directed at the residential and civic sectors. •Evaluate surrogate measures for occupational exposure such as: job titles, specific tasks, proximity to equipment. •Characterize the harmonic content of occupational exposures through spectral analysis at various locations. Characterize contact currents and shocks in the workplace. •Develop a small dosimeter for occupational exposure measurements. Consider the use of a biological indicator for exposure. •Identify unique exposures associated with specific locations and/or industrial processes.

Civic/Public Areas: •Collect 60 Hz E- and B-field exposure data in civic and public areas such as schools and hospitals. The data should be sufficient to generate various exposure metrics. The protocols and data should be compatible with studies in the residential and occupational sections. •Characterize 60 Hz E- and B-fields in schools and other locations such as hospitals and subways. This effort should include harmonics. Sources of exposures in public areas should be identified.

Other: •Assess need for combined exposures to E- and B-fields in animal studies. Evaluate conversion of existing E-field exposure facility to combined E- and B-field exposure facility. •Investigate combination AC and DC transmission line environment.

Laboratory: •Develop protocol to specify lab ambient environments, e.g. geomagnetic fields, 60 Hz levels, control areas. •Design a B-field exposure system with a waveform/temporal menu. This menu should reflect an effort to mimic selected aspects of human exposure. This system would then be used for 60 Hz field effects research on animals. Evaluate modification of existing E-field exposure facility. •Continue mechanistic research with exposures that vary in frequency, amplitude and temporal presentation.

Residential: •Collect 60 Hz E- and B-field exposure data. There should be enough data to produce various exposure metrics, including peak fields, time histograms, etc. The rationale for the metric(s) that are used is required. Ultimately, this will be a long-term effort with a large number of people keeping activity logs. A representative sample of society will need to be selected. Special subsets of the population that are of interest are those living near transmission lines and children. Because of the immensity of the project, an incremental approach is desired. A tractable sample size in one location would be used to establish protocols for expanding the study to several locations. •Perform B-field characterization: look for significant parameters such as diurnal variations; long-term stability; grounding systems; construction practices; geographic location; important sources related to power system and internal sources; spectral analysis to look at harmonics for both E- and B-fields. Determine appropriate meter response to characterize fields: 60 Hz or broadband. •Investigate ion penetration into residences. •Evaluate surrogate measures of residential exposure. •Perform

electric blanket exposure assessment. •Identify unique exposure situations including contact currents from appliances.

TERATOLOGY RESEARCH

Rationale: EPRI has long recognized the shortcomings of previous teratology studies and through research that it sponsored, developed E-field exposure cages free of the technical flaws of previous designs. This equipment is now being used in a teratology study in rats conducted at Battelle Northwest, where rats are exposed to 0, 10, 65 and 130 kV/m. The study was started in December, 1986.

The question was discussed whether adverse effects of B-fields on embryo development should be examined. No serious, scientifically sound studies are presently on record. The concern was voiced that EPRI is getting more and more involved in "defensive science," but with respect to B-fields, that argument was felt not to be applicable because there is no data base. The feeling was expressed that sooner or later, a B-field exposure teratology study would have to be conducted. The issue whether there should be simultaneous exposure to E- and B-fields was decided in favor of one or the other variable only to not confuse the issue and endanger the interpretability of the study results.

There is a need for EPRI to sponsor a teratology study on B-field exposure in the very near future. An engineering cost analysis should be initiated to decide whether it is more economical to retrofit the existing E-field exposure chambers presently used at Battelle or to design entirely new exposure chambers. It might be advantageous to combine both exposure possibilities in one piece of equipment for future experiments.

DIRECT CURRENT FIELD RESEARCH

...1. There is an important need for research to clarify the possible long-term effects of air ions and DC E-fields on laboratory animals. As with AC research, this information is needed as part of the overall data base for assessing the potential effects of HVDC transmission lines on people. Specific end points for laboratory animal research include, but are not limited to: •Survival rates; •Incidence of and progression of respiratory disease; •Levels of and/or response to neurotransmitters, e.g. serotonin; and •As a lower priority, consider the need for research on cancer and birth defects. A single, multi-generational study could address most of these end points. **Rationale:** Published results of the EPRI-sponsored air ion research by Kellogg et al. (1985) claim significant effects on mice from long-term air ion exposure, i.e., decreased lifespan. Although the research has been criticized by some on methodological grounds, one of the HVDC science advisors to the state of Minnesota (Bissel 1986) recently concluded that the Kellogg study is sufficiently plausible to deserve replication by EPRI. One of the only other studies to look at long-term air ion exposure, Hinsull et al. (1981), also reported some effects on neonatal survival and on pre-weaning growth rates of rats. Recent studies by Kellogg et al. (1985) and by Bailey and Charry (1984) found no evidence that air ion exposure influenced serotonin levels. However, a recent report by Dowdall and de Montigny (1985) suggested that such exposure can affect the sensitivity of brain cells to serotonin. This finding has now been replicated (de Montigny, personal communication). The serotonin issue, therefore, has not been fully resolved. *Estimated Cost: \$2-3 million.*

2. Short-term studies of humans are needed to assess the following: •Factors influencing perception of DC E-fields, including annoyance levels; •Mental state, including mood and performance; and •Individual differences among people in their

responses to air ions. **Rationale:** Research personnel and others who work near HVDC lines report that on occasion, E-fields are noticeable and in some cases, annoying. The latter appears to be related to both field strength and weather conditions. No systematic studies using representative subjects and conditions have been done to evaluate the occurrence of, and factors influencing human perception of DC E-fields. There is also a body of controversial research suggesting that air ions can influence mood and mental state in humans. Research by Charry and Hawkinshire (1981) also indicates there may be significant differences among people in their responses to air ions. *Estimated Cost: \$200,000-\$400,000.*

3. Research on HVDC electrical exposures is needed to address: •Identification of chemical ion species in power line environments compared to other situations, e.g. indoor laboratory animal environments; and •Measurements and modeling of the electrical environment where AC and DC transmission lines are in close proximity. **Rationale:** Although good information now exists on the concentrations of air ions produced by HVDC lines, information is lacking on air ion species near such lines. Also, it is important to know how air ions produced by DC lines compare to the air ion environment used in studies of laboratory animals. Preliminary information has been obtained by an EPRI-sponsored study (Georgia Institute of Technology) and this work should continue. *Estimated Cost: \$100,000-\$200,000.*

4. Work should begin on study design and protocol for laboratory animal research to assess the possible effects of combined AC and DC fields comparable to those produced by adjacent AC and DC power lines. **Rationale:** Recent research, e.g. Thomas et al. (1986), Blackman et al. (1985), indicate that certain combinations of AC and DC B-fields can produce biological effects in laboratory studies which are not produced by the separate fields. A hypothesis involving cyclotron resonance has been advanced to explain the phenomenon. *Estimated Cost: \$200,000-\$600,000.*

5. Work should begin to determine if there is a basis for laboratory animal research to determine if charged aerosols cause biological effects that differ from, or interact with, those that may be produced by air ions. **Rationale:** It is currently assumed that space charge, in the form of air ions and charged aerosols, leads to increased DC E-fields off the right-of-way of a DC line. Further, under some conditions, charged aerosols may be the primary component of DC E-fields off the right-of-way where residences may be located. There is little information available for assessing the possible biological effects of chronic exposure to charged aerosols. *Estimated Cost: \$50,000.*

6. Evaluate the need for and feasibility of epidemiological research involving people who live and/or work near HVDC transmission lines, possibly through a cooperative effort with individual utility groups. **Rationale:** Some preliminary epidemiological research involving HVDC lines has been done, however, with inconclusive and controversial results (e.g. Genereux and Genereux 1980, Nolfi and Haupt 1982). The New England Hydro-Transmission Corporation is investigating the feasibility of such research at the request of the states of New Hampshire and Massachusetts. *Estimated Cost: \$50,000-\$75,000 (feasibility study only).*

WHOLE ANIMAL STUDIES ON CANCER ISSUES

The following are the recommended animal studies which have the goal of developing an animal model for studying the

FROM THE FIELD

relationship, if any, between exposure to power frequency B-fields and cancer. The review committee emphasized that careful planning, including a review or a workshop on the laboratory data base, would be necessary to generate specific hypotheses for study. "Fishing expeditions" are specifically discouraged. In vitro cellular studies may provide models for "range finding" so that some notion of a meaningful dose metric might be developed to apply in the animal studies.

1. The first study is essentially a "pilot study" and would utilize specific mouse strains selected for responsiveness to cancer-promoting agents (e.g. B6, AKR or others) using treatment groups such as (a) [constant exposure over days to low and high fields - the "high" being approximately ten times the "low" field strength]; (b) "Electric blanket" exposure scenario: [eight hours of high exposure followed by 16 hours of low exposure]; (c) Random amplitude and duration [exposures].

2. A "primed" system study using treatment groups such as the following: (a) Mouse plus leukemogen plus B-field at $\Delta t = \Delta t$ in frequency and latency; (b) Model plus promoter (e.g. estrogen); (c) Model such as nude mouse, which has immune system deficiencies; (d) Fetal exposure and examine offspring for leukemia.

RISK ASSESSMENT RESEARCH PROJECTS

Rationale: The inability to define "dose" has severely limited investigators' efforts to apply conventional risk analysis techniques to the problems of 60 Hz fields (see the various works of Morgan, et al.). While it probably does not make sense to devote much additional effort to conventional risk analysis until the science is in better shape, there are some important related activities which should be undertaken at this time:

1. Develop materials designed to assist state regulators, members of the judiciary, state legislators, electrical utility managers and others who must deal with 60 Hz field issues to structure and think about the problems they face. Such guidance must include a fair articulation of what the science does and does not say; a fair explanation of which experiences and insights gained in the context of other risks extrapolate to the 60 Hz area and which do not; a clear statement of the importance of maintaining a relative risk perspective and of establishing bounds on the problem; and a clear framing of the choices and value judgments that managers and regulators must make. It would be worth involving several different groups in work of this kind.

2. While at this stage, the central scientific questions of existence of effects, nature of mechanisms and characterization of "dose" should drive the research agenda, a risk analytic perspective may be useful in helping to establish some research priorities and in keeping the research program focused on its basic risk-related objectives. The level of effort devoted to this second task should be modest.

MECHANISMS OF INTERACTION

The following is a listing of the eight recommendations, with an asterisk placed after those areas of research that are currently funded by EPRI, DOE or other sources:

1. (*) Continued research on transmembrane signalling events and the activation by EMFs of cAMP, cellular kinases and other enzyme systems that are controlled kinases.

2. Determination of thresholds for ELF field effects using well-defined in vitro systems and quantitative biological/biochemical end points. These thresholds relate to field amplitude and frequency dependence, temporal variations in the expression of

bioeffects and the magnitude of these effects as a function of exposure duration.

3. Devise a sensitive in vitro model for studying the relative potencies of various field exposure regimens (e.g., different on-off cycles using a field intensity that elicits a quantifiable effect during continuous exposures of approximately one hour duration).

4. (*) Additional work on "transcription" and "translation" effects of ELF fields, such as the altered messenger RNA expression and protein synthesis in dipteran salivary gland cells (research by Goodman, Henderson and others).

5. Replication of key experiments conducted in vitro such as the Winters/Phillips studies on growth rate and membrane receptors in human colorectal adenocarcinoma cells.

6. (*) Extend studies on the pineal gland as a potentially sensitive site of ELF field interactions. Explore melatonin interactions with other hormones (e.g., estrogen) that are known to influence cancer risk in certain tissues (e.g., the female breast).

7. Enhance efforts to develop realistic theoretical models of ELF field interactions at the cellular, membrane and molecular levels of biological organization.

8. Initiate studies on synchronized cell populations in vitro to gain information on the cell-cycle-phase dependence of ELF field interactions (i.e., to detect differential sensitivity between quiescent cycling cells, and between G-1, S and G-2 cells in cycling populations).

CONFERENCE CALENDAR

New Listings

May 15-18: Spring Conference of the Society of Telecommunications Consultants (STC), Sheraton Hotel, New Orleans, LA. Contact: Effie Cooper, STC, One Rockefeller Plaza, Suite 1410, New York, NY 10020, (212) 582-3909.

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 22-23: 19th Annual North American Power Symposium, University of Alberta, Edmonton, Canada. Contact: Dr. D.O. Koval, Dept. of Electrical Engineering, University of Alberta, Edmonton, Alberta T6G 2G7, Canada, (403) 432-2481.

November 11-12: International Monotech'87 Conference on Electrotechnologies, Montreal, Quebec, Canada. Contact: J.P. Cristel, Canadian Committee on Electrotechnologies, 1 Westmount Sq. (525), Montreal, Quebec H3Z 2P9, Canada, (514) 931-5921.

November 13-16: 9th Annual Conference of the IEEE Engineering in Medicine and Biology Society, Park Plaza Hotel, Boston, MA. Contact: Dr. Ronald Newbower, Dept. of Biomedical Engineering, Massachusetts General Hospital, Boston, MA 02114, (617) 726-1676.

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UPDATES

BIOLOGICAL EFFECTS

Special Issue...The March issue of the *IEEE Engineering in Medicine and Biology Magazine* is devoted to the "Effects of EM Radiation." Among the areas covered in the ten papers are: cellular effects, by Dr. Steve Cleary; teratogenic effects, by Dr. Joe Lary; immunological effects, by Dr. Ralph Smialowicz; and the 1982 ANSI safety standard, by Dr. Om Gandhi, who highlights the potential hazards due to shocks and burns below 30 MHz and heating by millimeter waves. Single copies are available for \$3.00 for IEEE members and \$14.00 for others from IEEE, 445 Hoes Lane, Piscataway, NJ 08854, (201) 981-0060.

COMPATIBILITY & INTERFERENCE

Power Lines and PCs...60 Hz magnetic fields can cause displacements of the electron beam in a CRT, resulting in the distortion of characters on the computer display, according to a study of "Interference from 60 Hz Electric and Magnetic Fields on Personal Computers" by Rod Baishiki of PG&E in San Francisco, CA, and Dr. Don Deno of GE in Lenox, MA. The type of distortion depends on the orientation of the field relative to the monitor; the operator's sensitivity to the distortion is related to the vertical scanning frequency. The distortions can be eliminated by placing Mu metal shielding around the monitor. Baishiki and Deno also address the risks associated with electric fields - spark discharges. Their paper appears in the April issue of the *IEEE Transactions on Power Delivery*.

EMI from HVDC Stations...A research team from the International Engineering Co. in San Francisco, CA, and Ohio State University in Columbus has developed a computer program that can calculate the voltages and currents associated with 5-500 kHz noise in HVDC converter stations. Predictions conformed "reasonably well" with the measured values. This study is an extension of earlier work by the same group (see *MWN*, May 1985); both were funded by EPRI. *Radio Interference from HVDC Converter Stations: Modeling and Characterization* (No. EL-4956), December 1986, is available, pre-paid, for \$32.50 from the Research Reports Center, PO Box 50490, Palo Alto, CA 94303, (415) 965-4081. Overseas orders cost \$65.00.

Lightning Downs Rocket...An Atlas-Centaur rocket carrying a U.S. Air Force communications satellite had to be destroyed on March 26 when it veered out of control a minute after it was launched from Cape Canaveral, FL. Although an investigation is far from complete, NASA officials believe that lightning was responsible; one investigator said that the storm's electromagnetic field may have been the cause. Early

speculation that explosive bolts on the rocket's nose cone may have been detonated by the lightning was dismissed when the bolts were later recovered intact.

GOVERNMENT

FCC Modifies RF/MW Rules...The FCC has issued two refinements to its regulations for RF/MW radiation-emitting devices. In February, the commission issued a final rule exempting land-mobile, cellular radio and microwave point-to-point communications, as well as most auxiliary broadcast services, from having to prepare environmental assessments under the National Environmental Policy Act (NEPA). These exemptions were first proposed in 1985 at the same time that the commission issued its NEPA rules (see *MWN*, April 1985). Experimental and commercial broadcast stations and satellite communication stations must still comply with the environmental rules. The FCC has also issued a proposal to protect against potentially hazardous RF/MW radiation from shipboard radars and satellite uplinks. If adopted, the rules will require manufacturers of marine radars and uplinks to provide guidelines for the safe installation and operation of their equipment because, according to the FCC, "the possibility does exist for significant [radiation] exposure." The commission notes that the proposed rules "would be administratively more feasible than requiring separate environmental analysis of every application for a ship-earth or radar station." At press time, the final and proposed rules were scheduled to be published in the *Federal Register* in mid-April and at the end of April, respectively. Still pending before the FCC is a petition filed by the National Association of Broadcasters asking for federal preemption of state and local RF/MW radiation safety standards (see *MWN*, May/June 1986). For more information, contact the FCC's Bob Cleveland, Office of Engineering and Technology, FCC, 1919 M St., NW, Washington, DC 20554, (202) 653-8169.

MEETINGS

Magnetotherapy in Hungary...The 2nd Hungarian Symposium on Magnetotherapy will be held May 16-17 in Szekesfehervar. Many fascinating presentations are scheduled. Among them: Dr. Yu. Kholodov and coworkers from the Institute of Higher Nervous Activity and Neurophysiology in Moscow, U.S.S.R., on "Nervous System Reactions to Magnetic Fields"; Dr. A. Prusinski and coworkers from the Medical Academy of Lodz, Poland, on "PEMFs in the Therapy of Headaches"; Drs. Z. L. Schubert and P. Kapp of the University of Veterinary Sciences in Budapest, Hungary, on "The Effect of Long-Term PEMFs on Dog Embryos and Young Animals"; and Drs. E.S. Vainshtein and L.V.

UPDATES

Zobina of the Helmholtz Research Institute of Ophthalmology in Moscow, on "PEMFs for Eye Diseases." For more information, contact: Dr. A. Guseo, H-8001 Szekesfehervar, Seregelysei u.3, Hungary.

Harmonic Conference...The proceedings of the *2nd International Conference on Harmonics in Power Systems*, held October 6-8 in Winnipeg, Manitoba, Canada, have been reprinted, and a limited number of copies are still available for \$100.00 Canadian or \$80.00 U.S. each. To order your copy, write to Manitoba HVDC Research Center, 400-1619 Pembina Highway, Winnipeg, Manitoba R3T 2G5, Canada.

PEOPLE

Edwin Carstensen, professor of electrical engineering and biophysics at the University of Rochester, NY, has been elected to the National Academy of Engineering. The academy cited his contributions to "the understanding of ultrasonic and dielectric properties of biological media and the biological effects of ultrasound and ELF electric fields."

Charles Miller has retired as the chief of the Electromagnetic Fields Division at the National Bureau of Standards in Boulder, CO. Dr. Ramon Baird has taken over as the acting chief of the division.

The two leading manufacturers of hyperthermia equipment continued their feud in March - this time, over executive talent. Victor Vaguine resigned as executive vice-president of Clini-Therm Corp. and replaced James Skinner as president and CEO of BSD Medical Corp. It is not clear whether Skinner resigned or was forced out. The two companies will be in court later this year over the patent infringement suits each company filed against the other (see *MWN*, March/April 1986).

STANDARDS

IEC and CISPR...The IEC recently published *Radio-frequency Cables. Part 1: General Requirements and Measuring Methods* (No.96-1), \$47.00, and *Methods of Measurement for Radio Equipment Used in Satellite Earth Stations. Part 1: Measurements Common to Sub-Systems and Combinations of Sub-Systems. Section 4: Measurements in the Baseband* (No.510-1-4), \$27.00. Both are available, prepaid, from the American National Standards Institute's (ANSI) Sales Dept., 1430 Broadway, New York, NY 10018, (212) 642-4900; add \$5.00 for postage and handling for one publication, or \$6.00 for both....CISPR has issued *CISPRIG(Central Office)2, Amendments to CISPR Publication 22: Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment* as

a six-month draft rule. It is available for \$9.00, prepaid, from ANSI.

VDTs

VDT Radiation Meters...It is now much easier to measure the electromagnetic fields associated with VDTs; two companies are marketing VDT radiation meters. Dr. Hari Sharma of the University of Waterloo in Ontario, Canada, has designed the EMF 1, which can measure both ELF and VLF fields. It has been evaluated by Professor S.N. Karla, also of the University of Waterloo. The meter costs \$600.00 (U.S.), plus shipping and handling; allow eight weeks for delivery. EKM Associates, Inc., is the exclusive distributor for Sharma's meter in the U.S. and Canada. Only a limited number of the meters are now available; more will be produced if there is sufficient demand. Contact: Ms. Sigrid DiBella, EKM Associates, Inc., 342 Consumers Rd., Willowdale, Ontario M2J 1P8, Canada, (416) 497-0605. Holaday Industries, well-known for its line of RF/MW measurement units, is also planning to introduce a VDT meter in the next few months. The meter will have both magnetic and electric field probes, in addition to a liquid crystal display. It will pick up signals in the 10-100 kHz frequency range. Holaday expects that its meter, Model HI-3600, will be available for delivery in July for less than \$1,000. For more information, contact Holaday Industries, 14825 Martin Dr., Eden Prairie, MN 55344, (612) 934-4920.

ETC...

An Idea Whose Time Has *Not* Come...The design of consumer products has entered a new phase with the advent of "product semantics," the concept that products should be designed to communicate visually. Examples include hair dryers with wavy shapes and tea kettles with birds at their spouts for whistling. According to *The Wall Street Journal* (March 26), Philips Industries developed a microwave oven in the shape of a fondue pot, for use at the dining room table. The design looked more like a nuclear power plant, however, and was shelved.

Look Ma, No Laser...Last Christmas, among the hottest new toys were laser guns, including Mattel's Neutra-Laser, Remco's XSL Phaser Command and Worlds of Wonder's Lazer Tag. Researchers at the Electro-Optics Branch of the FDA's Center for Devices and Radiological Health began to wonder whether the guns' radiation could harm children's eyes and tested the models made by six different manufacturers. They quickly discovered that none of them use a laser; instead, the beams are simulated by infrared-LEDs, flashtubes or even light bulbs. The center concluded that the tested products "do not pose any known biological hazard."

On April 8, the House Armed Services Committee approved an amendment to the 1988 Defense Authorization Act, offered by U.S. Congressmen Roy Dyson, a Maryland Democrat, and Herbert Bateman, a Virginia Republican, which would bar the Navy from testing EMPRESS II on Chesapeake Bay during fiscal year 1988. Last year Congress approved a similar amendment, sponsored by Dyson, that stops all EMP testing on the bay during the current fiscal year.

Dyson has argued that it makes no sense for the federal government to spend millions of dollars to clean up the bay and, at the same time, support a project that might have the opposite effect.

The Navy selected Chesapeake Bay as its preferred site on which to test whether its ships can withstand the EMP of a nuclear blast. EMPRESS II can produce pulsed electric fields of 50 kV/m at 100 yards at 30-minute intervals. The simulator, which would be floated on a barge near Bloodsworth Island, would replace EMPRESS I, a smaller simulator based at the Patuxent Naval Air Test Center on the shore of the bay.

The Chesapeake Bay choice has long stirred strong environmental opposition. Maryland officials, who are already on record as opposing the Navy's plan, contend that operation of EMPRESS II might shut down the Port of Baltimore for 20 days per year (see *MWN*, January/February 1987). According to the SDEIS, the Navy would operate EMPRESS II for as many as 60 days per year - 20 days on Chesapeake Bay and 40 days at sea.

In comments on the Navy's Supplemental Draft Environmental Impact Statement (SDEIS), the federal Environmental Protection Agency (EPA) reaffirmed its previous opposition to siting EMPRESS II on the bay. In a February 27 letter, John Pomponio, the chief of the environmental impact and marine policy branch at EPA's Region III office in Philadelphia, PA, wrote that, "Based upon the inconclusive results of the short-term impact studies [contained in the SDEIS] we do not agree with the SDEIS that EMPRESS II will cause no impact to organisms of the Chesapeake Bay."

EPA was particularly critical of the Navy's interpretations of the short-term studies in the SDEIS. "The statistics presented in the report do not clearly support the conclusions that were drawn," the letter stated. The agency cited numerous scientific shortcomings; it chided the Navy for the incompleteness of the experiments on fish and birds.

Noting that the Navy had acknowledged the studies' shortcomings, EPA concluded that, "Because of the Navy's doubts as well as our own we suggest that [EMPRESS II] not be deployed in the Chesapeake Bay."

Similarly, a top-ranking Virginia environmental official argued that locating the simulator on the bay "would pose unacceptable environmental, social and economic risks which we are not prepared to take."

The official, Keith J. Buttleman, administrator of Virginia's Council on the Environment, also suggested that the Navy has not handled the siting process fairly.

Environmental Assessment of DOD's EMP Research Sought

Two environmental groups have asked a federal court to block the U.S. Air Force, Army and Navy from using all electromagnetic pulse (EMP) simulators until a "complete and thorough programmatic" environmental impact statement (EIS) has been prepared.

On March 9, the Foundation on Economic Trends, in Washington, DC, and the Potomac River Association, in Valley Lee, MD, sued the Department of Defense (DOD) in the U.S. District Court for the District of Columbia, arguing that EMP simulators "pose a grave potential threat to the environment and public health."

The Pentagon has refused comment on the suit.

In recent years, Jeremy Rifkin, the president of the foundation, has filed and won a number of lawsuits seeking EISs on the environmental risks associated with the commercialization of recombinant DNA technology. In February, a federal judge sided with Rifkin and ordered DOD to prepare a programmatic EIS on its biological warfare research program.

Rifkin's EMP lawsuit is the latest indication of a growing public awareness of EMP technology. Last year, two Washington-area individuals petitioned the Federal Communications Commission (FCC) to open a notice of inquiry on the threat of EMPs to civilian communication systems. Their petition was rejected by the FCC, but in January, they asked the commission to reconsider (see *MWN*, September/October 1986 and January/February 1987).

"The decision process is a source of much concern and leaves us with the impression that decision makers are not amenable to dispassionate investigation of the matters that should be known before such a momentous decision is made," he wrote in a February 13 letter to the Navy.

Elected officials from Maryland are adding to the pressure on the Navy. On March 24, the Maryland House of Delegates unanimously approved Joint Resolution 42, sponsored by Samuel Q. Johnson, III, which would stop the Navy from siting EMPRESS II on the bay. The House of Delegates passed a similar resolution two years ago (see *MWN*, April 1985). The State Senate held a hearing on the resolution on April 3 and is expected to pass it, according to a legislative aide.

Two key EMPRESS II staffers have left or will leave the Navy in the near future. Captain B.L. Powers, manager of the Navy's Theater Nuclear Warfare Program, which includes EMPRESS II, will soon retire. Lt. Commander A. Gritzke, the project manager for EMPRESS II, retired on April 1.

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