MICRO WAVE NEWS

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INSIDE...

ELF Effects Across Generations

Chronic exposure to extremely low frequency (ELF) fields may adversely affect the reproduction and development of experimental animals, according to major new multi-generation studies. The findings are controversial and inconsistent, however. The Electric Power Research Institute (EPRI), which paid for the research, has agreed to support more long-term studies.

Experiments on three generations of rats and miniature swine at the Battelle Pacific Northwest Laboratories in Richland, WA, indicate that offspring of chronically exposed animals are most at risk. Females born and bred in 60 Hz electric fields and mated with unexposed males may yield progeny with more birth defects and lower weights than controls.

The Battelle studies appear to confirm the results of three-generation studies on mice by Drs. Andrew Marino and Robert Becker in the mid-1970s (see box on p.14).

One working hypothesis for the observed effect is that ELF fields might alter the timing of hormonal secretions from the pineal gland, which could in turn affect growth and development, according to Dr. Larry Anderson of Battelle. Chronic exposure to 60 Hz fields has been shown to affect the release of melatonin from the pineal gland in rats (see B.W. Wilson et al., *Bioelectromagnetics, 2,* pp.371-380, 1981).

Long-Term v. Short-Term Studies

EPRI's decision to fund long-term replication studies on rats is a reversal of an earlier policy announced last November by Dr. Gordon Newell, an EPRI senior program manager, to pay only for short-term studies. Dr. Richard Phillips, the former director on both the rat and swine projects, publicly criticized EPRI's initial reluctance to fund chronic exposure studies in the face of the experimental results.

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Walkie-Talkie RFI in Nuclear Power Plants

Operators of nuclear power plants are experiencing a growing number of radiofrequency interference (RFI) problems, and the Nuclear Regulatory Commission (NRC) has warned that RFI could create potentially hazardous situations.

In the three most recent incidents, hand-held walkie-talkie radios caused the loss of offsite power twice in five days at the Palo Verde reactor No.1 in Arizona and once at the River Bend facility in Louisiana. At both sites, the NRC explained in a statement issued in March, walkie-talkies interfered with transceivers in the fiber optics systems.

Eric Weiss, an NRC spokesman, said that none of the incidents posed a danger to workers or to the public.

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HIGHLIGHTS

Swedish Mice Study Links VDT Radiation to External Fetal Malformations

Simulated video display terminal (VDT) radiation emissions can cause fetal abnormalities in mice, according to Swedish researchers. In Stockholm, Drs. Bernhard Tribukait and Eva Cekan, of the Karolinska Institute, and Lars-Erik Paulsson of the National Institute of Radiation Protection have reported that fetuses exposed to VDT-like pulsed magnetic fields (PMFs) experienced nearly five times the rate of malformations as unexposed controls. The results are preliminary and the study is continuing.

The findings "might indicate that PMFs of this specific type [have] teratogenic effects," the investigators concluded in a study abstract they prepared for an international VDT conference scheduled for May in Stockholm.

In a telephone interview from his office at the Department of Medical Radiobiology in Stockholm, Tribukait explained that the exposed fetuses suffered an unusual number of rare, external abnormalities. "We have to look more carefully at the external malformations," he said. According to the abstract, the rate of internal malformations was consistent with that of the control group.

The Swedish National Board of Occupational Safety and Health (NBOSH), which is sponsoring the upcoming conference, released the study abstract. At a January 30 press conference, Dr. Ricardo Edstrom, NBOSH's medical director, expressed surprise at the results, saying that they were "totally unexpected" and that "we can no longer rule out the possibility that radiation could affect fetuses," according to press reports from Stockholm. He also observed that the findings might force the Swedish government to change its VDT work regulations to protect pregnant women but nonetheless cautioned that the results cannot be applied directly to humans.

Findings Contested

Other officials at NBOSH soon challenged the findings, however, charging that the statistical analyses failed to account for deaths and resorptions among the mice litters. Following two weeks of rumors that NBOSH would retract the study results, the agency released a statement on February 13 that downplayed but did not dismiss them. The board emphasized that it would not change its regulations for VDT work.

"A later-performed analysis, based on the combinations of living malformed, dead and resorbed fetuses, does not suggest any damaging effect," the statement explained. "In conclusion," it went on, "adverse pregnancy outcome effects due to VDT work have not been demonstrated."

Tribukait rejected NBOSH's method of analyzing the data. It is "bad policy" to combine the data on resorptions, deaths and malformations because resorptions normally occur at high rates in the strain of mice used, he explained to *Microwave News*. "They cannot be combined, not by my methods."

He also said that he was opposed to NBOSH's original decision to release the study abstract and that the board did not contact him before releasing its February 13 memo. According to press reports, Edstrom released the abstract because he believed the findings were too important to withhold, but NBOSH officials did not explain why the agency contested the results just two weeks later. One Swedish scientist who has followed the study closely said that the challenge to the data was "political business."

Experimental Setup

Tribukait, Cekan and Paulsson exposed four groups of pregnant C3H mice to weak PMFs and used a fifth group as unexposed controls. They applied two types of pulses, each at field strengths of 1 or 15 microtesla (uT): a sawtooth-shaped pulse simulating the PMFs emitted by a VDT's flyback transformer and a rectangular pulse resembling one used by Drs. Jose Delgado and Jocelyne Leal in Madrid, Spain (see *MWN*, November 1983 and January/February 1986). The sawtooth pulses, at 20 kHz, had rise and fall times of 45 and 5 microseconds (usec), respectively. The rectangular pulses had a width of 0.5 milliseconds and rise and fall times of 2 usec, with a repetition rate of 100 Hz.

In the experiments, each of the five groups contained 40-60 mice and 230-340 fetuses. The researchers found nearly five times the rate of malformations in the fetuses exposed to the 15 uT sawtooth-shaped pulses, compared to the controls (3.3 percent v. 0.7 percent). For the 1 uT sawtooth pulse, 2.7 percent of the mice developed abnormalities; combining the fetuses exposed to 1 and 15 uT sawtooth pulses produced a malformation rate of 2.9 percent.

The rectangular pulses, on the other hand, produced virtually the same rate of malformations as the controls. None of the pulses significantly affected the rates of resorptions, fetal deaths or body weights.

The abstract noted that the historical rate of malformations for the C3H mice strain is approximately 1.4 percent, double the rate observed in the experimental control group. Tribukait acknowledged the low rate and attributed it to the small sample size studied so far. He emphasized, however, that external malformations in the exposed mice were of a different type than those identified in the control group.

Confusion and Controversy

Confusion surrounded the study results as labor, industry and government officials reviewed the data, seeking to resolve the conflicting NBOSH views. Elizabeth Lagerlof, an attache at the Swedish Embassy in Washington, DC, told *Microwave News* that she was swamped by inquiries.

Swedish labor officials reportedly are concerned that NBOSH's February 13 memorandum might be used to

limit research efforts on reproductive risks and other VDT-related health issues. Lagerlof said that the unions are aggressively pressing the government to fund an expanded research program. Both Tribukait and Paulsson told *Microwave News* that the experiments will continue and will be attempted in other labs, as well.

An indication that the study results were not clearly understood appeared in the popular British magazine, the *New Scientist*, which reported on February 20 that Swedish government officials had "dismissed" concerns about magnetic fields from VDTs.

Dr. John Harris, IBM's director of product and process engineering, visited the Karolinska Institute in March, while on a business trip in Europe. An IBM statement, prepared at the request of *Microwave News*, said that "Harris is one of a number of IBMers involved in discussing [the PMF] work and his meeting...simply continued that dialogue."

Radio Station Closes in Face of FCC RF Rules

Citing the high cost of compliance, the owner of a California FM radio station has given up his broadcasting license rather than comply with the Federal Communications Commission's (FCC) rules for radiofrequency (RF) radiation. Daniel Healy, the owner of KERG in Garberville, told the FCC on March 17 that compliance with the FCC's radiation standard would be "prohibitively difficult and expensive."

The station's troubles began last fall when state engineers measured RF levels atop a fire lookout tower near the KERG transmitter. They found readings that were two to three times higher than the 1 mW/cm^2 exposure limit adopted by the FCC (see *MWN*, September/October 1985). The commission, which had approved a KERG request to increase its power output from 2 kW to more than 50 kW, ordered the station to cut back to 2 kW to protect forest rangers manning the lookout.

When the rangers left the tower at the end of the fire season last fall, the FCC allowed the station to resume broadcasting at full power. The commission stipulated, however, that KERG had to devise a way to meet the exposure limit before the fire season started again this spring.

In a telephone interview, William Hassinger of the FCC's Mass Media Bureau said that he was surprised by KERG's decision to shut down. *Microwave News* tried to reach Healy at KERG a week after he gave up his license, but the station's phone had already been disconnected.

Cancer Fears on Vashon Island, Washington

Washington state health officials are examining the incidence of cancer among people living near a satellite communications complex on Vashon Island, following allegations of an abnormal pattern of brain and endocrine cancers in the area.

Donald and Marcia Montgomery reported what they believe to be a cancer cluster in Paradise Valley around a satcom earth station operated by Alascom, which handles telephone traffic between the mainland U.S. and Alaska. In a letter to the local newspaper, the *Vashon-Maury Island Beachcomber*, the Montgomerys claimed that, over the last two years, nine of their neighbors had developed cancer. Five of the cases occurred among women under forty.

Dr. Samuel Milham, an epidemiologist with the Washington State Department of Social and Health Services in Olympia, well known for his studies of workers exposed to electromagnetic fields, is looking into the number and types of cancer. Most clusters do not check out, Milham told *Microwave News*, adding that he was skeptical about this particular case because the latency period for the development of cancer was too short — the power was turned on at the Alascom station in 1983.

Jay Becker, the editor of the *Beachcomber*, said that plans are underway for a house-to-house health survey of the residents of the approximately 117 houses near the Alascom station. Preliminary data from the Fred Hutchinson Cancer Research Center indicate that Vashon residents had a normal cancer rate for the period between 1973 and 1984, according to Becker. The survey will collect data about cancer, as well as Down's Syndrome, following the confirmation of an abnormal cluster of Down's cases in Vernon Valley, NJ, where there are three satcom stations (see *MWN*, May and November/December 1985).

RCA also has built a satcom station on Vashon Island after meeting strong opposition on nearby Bainbridge Island (see *MWN*, July/August 1982). The RCA station is on a 105-acre site, while the Alascom complex is on a much smaller plot, with houses and farms nearby.

Vashon for a Quality Environment, a citizen's group, has been fighting the Alascom station for years. Recently, under pressure, Alascom agreed to complete an environmental impact statement for the station — even though it is operational. Other radiation disputes have resulted in a 1 uW/cm^2 public exposure standard from microwave sources, according to Roger Leed, a Seattle attorney for Vashon citizen and community groups.

More on ELF Fields and Cancer

Outlined below are some of the latest research developments on the possible relationship between extremely low frequency (ELF) fields and cancer.

"Something Is Going On"

A consensus is emerging that exposure to ELF fields is linked to an increased incidence of cancer, according to presentations at a *Panel Session on Biological Effects of Power Frequency Electric and Magnetic Fields* held in New York City in early February. Drs. Tom Tenforde and David Savitz both said that the growing number of studies indicate that "something seems to be going on" among workers exposed to electromagnetic fields (EMFs).

After completing a comprehensive review of ELF bioeffects, Tenforde said there is a "real need" to do epidemiological studies of electric and electronic workers. Tenforde, who is with the Lawrence Berkeley Lab in California, noted that 15 of 17 reports showed "some apparent correlation between cancer and EMFs." One complicating factor, Tenforde noted, was the absence of a consistent dose-response relationship.

Savitz, who recently joined the University of North Carolina School of Public Health in Chapel Hill after leaving the University of Colorado, echoed Tenforde's concerns. In an interview with *Microwave News*, Savitz said that, when all the existing cancer data are grouped together, there seems to be a "consistent overall increased risk." He added that while the occupational data indicate a cancer link, risks associated with residential exposure need further study before a causal association could be shown.

Savitz said that the observed links cannot be explained by any known biases: "There are positive findings that cannot be dismissed." He noted that, because exposures tend to be diluted in the study populations, "the effect may be much stronger than studies are showing." Savitz also said that one of the weaknesses of the existing data base is the lack of accurate exposure information.

The organizer of the panel session, Dr. William Feero, warned that if there are health problems associated with EMFs, "we are talking about the whole electrical economy, not just power lines."

Attendance was relatively poor, given the interest in the power line bioeffects issue: only 45 (including speakers) of the more than 2,200 registrants at the *IEEE Power Engineering Society (PES) Winter Meeting* showed up at the panel session. The PES meeting was held in New York City, February 2-7. Copies of the booklet containing the five papers presented at the panel session are available for $20.00 (prepaid), plus a $3.00 handling charge, from Single Publications Sales Dept., IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. Order No. 86TH0139-6-PWR.

McDowall and Coleman in the UK

Two recent reports from England indicate no clear relationship between cancer and non-occupational exposures to EMFs.

In a mortality study of people living near electrical transmission facilities, Dr. Michael McDowall of the Office of Population Census and Surveys in London found a significant excess of lung cancer in women, but not in men, and a less than significant increase in leukemia among women. Overall mortality in the study population was lower than expected, and McDowall reported no excess deaths from all cancers or all leukemias. He concluded, however, that the data for acute myeloid leukemia and lymphatic cancer were "inconclusive."

Lung cancer deaths appeared to show a dose-response relationship to proximity to electrical facilities. In addition, McDowall found a higher proportion of fatalities due to lung cancer, leukemias, other lymphatic neoplasms and circulatory and respiratory diseases among those living within 15 meters of such installations. Only the lung cancer results were statistically significant.

Florida To Set Power Line EMF Rules

The Florida Department of Environmental Regulation (DER) is developing rules for the siting of transmission lines, including criteria for electromagnetic field (EMF) exposures. The action came after the state's Siting Board denied the Florida Power Corporation a permit to build a 500 kV line near Tampa, in part because the DER had not adopted EMF rules.

After a number of siting disputes, the state legislature authorized the DER to set radiation exposure standards in 1983, but never allocated the funds necessary to do the job (see *MWN*, July/August 1983 and July/August 1984). Following the March 18 decision, Governor Bob Graham agreed to make contingency money available to the DER.

According to the DER's Karen Anthony, the department is considering a number of policies for EMFs, including setting electric and/or magnetic field exposure limits and specifying a minimum right-of-way (ROW) along a power line route. Last summer, the DER recommended a 190-foot ROW for the now-rejected 500 kV Lake Tarpon-Kathleen line (see *MWN*, September/October 1985).

A workshop is planned for mid-April and rules could be set by the end of the year, Anthony said.

For more information, contact Buck Oven, DER, 2600 Blair Stone Rd., Tallahassee, FL 32301, (904) 488-0130.

McDowall noted that the exposures of the majority of the study population were relatively low. He plans to continue monitoring mortality patterns. His paper was published in the February 1986 issue of the *British Journal of Cancer, 53,* pp.271-279.

Preliminary results of a case-control study by Dr. Michel Coleman of the Imperial Cancer Research Fund at the University of Oxford showed no overall association between leukemia and residential proximity to overhead power lines, although the data did suggest a "weak positive" effect — though the relationship between risk and distance to power lines was not statistically significant.

Coleman's study population, like McDowall's, had only low exposures to EMFs: less than one percent of the cases lived within 100 meters of an overhead power line. In addition, nearly the whole distribution network in the study area consisted of underground cables of less than 132 kV.

Coleman presented his findings at the *IEE International Conference on Electric and Magnetic Fields in Medicine and Biology,* held last December in London. He told *Microwave News* that he is preparing a paper for publication.

In 1983 McDowall and Coleman independently reported an increased risk of leukemia among workers exposed to electromagnetic fields (see *MWN,* March and June 1983).

Cancer Among Swedish Telecom Workers

Continuing their investigation of cancer incidence in the telecommunications industry, Dr. D. Vagero and coworkers have identified a 2.6-fold excess risk of malignant melanoma among workers compared to the Swedish population as a whole. The risk was even higher in workplaces where soldering was done.

In a related mortality study of Swedish electrical engineers, the same research group found a greater than threefold risk of malignant melanoma, compared with that of the general population, although only three cases were reported. But the engineers' overall mortality rate was "considerably" lower than expected, as was the number of cancer deaths. Both papers appear in the *British Journal of Industrial Medicine, 42,* pp.191-195 and pp.211-212, 1985. (See *MWN,* December 1983 for a discussion of the group's first paper.)

Milham on Leukemia and Lymphoma

At a 1984 conference, Dr. Samuel Milham of the Washington State Department of Social and Health Services reported a greater than expected number of deaths due to leukemia and non-Hodgkin's lymphomas among Washington state workers employed in occupations considered to involve electric or magnetic field exposures. His paper, presented at the *5th Annual Symposium on Environmental Epidemiology* in Pittsburgh, PA, has now been published in the October 1985 issue of *Environmental Health Perspectives, 62,* pp.297-300 (see also *MWN,* July/August 1982 and May and July/August 1985).

BSD v. Clini-Therm: Hyperthermia Patent Suit

The only two manufacturers of government-approved hyperthermia systems are suing each other. In February, BSD Medical Corp. of Salt Lake City, UT, charged Clini-Therm Corp. of Dallas, TX, with patent infringement and unfair competition. Clini-Therm responded with a counterclaim, alleging that BSD's patent was invalid and that BSD was engaging in unfair competition and violating antitrust laws.

At issue is the growing market for hyperthermia systems to treat cancer. BSD was the first to win clearance from the Food and Drug Administration (FDA): in late 1983, the BSD-1000 was judged "safe and effective" and in February 1984 the BSD-300, a mobile treatment unit, was similarly approved (see *MWN,* May 1983 and January/February 1984). The BSD-1000 delivers 50 to 1,000 MHz radiation with a variety of applicators. The FDA cleared Clini-Therm's external microwave hyperthermia system last August and an interstitial system in October (see *MWN,* November/December 1985).

In its suit filed on February 4 in U.S. District Court in Dallas, TX, BSD accused Clini-Therm of copying its interstitial applicator without permission and of misrepresenting BSD's financial status. In a telephone interview with *Microwave News,* BSD President James Skinner said that Clini-Therm had insinuated to potential customers that BSD was not a viable company and had told them to avoid BSD hyperthermia systems in favor of its own equipment. BSD, which did not specify the amount of damages it is seeking, is represented by Keith Nowak of Lieberman, Rudolph & Nowak of New York City.

Clini-Therm filed its counterclaim in the same court two weeks later. It denied BSD's allegations and asked the court to declare the BSD patent invalid and to stop BSD from making false and misleading statements about Clini-Therm and its products. Clini-Therm is trying to recover damages for lost sales and punitive damages of $1.5 million.

According to James Bradley of Richards, Harris, Medlock & Andrews in Dallas, who is representing Clini-Therm, the BSD patent is invalid because it was issued erroneously. In addition, Clini-Therm charged BSD with engaging in predatory pricing policies and with violating federal antitrust laws.

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Australia Sets A Strict RF/MW Exposure Standard

The new Australian safety standard for public and worker exposures to radiofrequency and microwave (RF/MW) radiation is one of the strictest outside of the Soviet Union and Eastern Europe. Issued in 1985, the national standard is based on the "as low as reasonably achievable" — or ALARA — principle.

The developers of the standard adopted a cautious attitude towards radiation risks — especially with respect to protecting the general public:

> "Because the effects of...exposures to electromagnetic fields are only imperfectly understood, it is recommended that the levels of all electromagnetic fields to which people are non-occupationally exposed should be kept *as low as reasonably achievable*." [emphasis in the original]

A "Flat" Standard

The standard differs from those used in other "Western" countries in two crucial aspects. First, it is frequency-independent — or "flat" — between 30 MHz and 300 GHz, limiting exposures to 1 mW/cm² for workers and to 200 uW/cm² for the general public; second, it specifies special precautions to safeguard against RF shocks and burns. (See Tables below.)

MAXIMUM OCCUPATIONAL EXPOSURE LEVELS

CONDITION A

Frequency	Mean power flux density (*S*)†	
	W/m²	mW/cm²
300 kHz ≤ 9.5 MHz	100	10
> 9.5 MHz ≤ 30 MHz	9000/f^{2}*	900/f^{2}*
> 30 MHz ≤ 300 GHz	10	1

CONDITION B

Frequency	Mean power flux density (*S*)†	
	W/m²	mW/cm²
300 kHz ≤ 3 MHz	1000	100
> 3 MHz ≤ 30 MHz	9000/f^{2}*	900/f^{2}*
> 30 MHz ≤ 300 GHz	10	1

NOTE: Values of *S* are averaged over any 60-second period.

*f = frequency in megahertz.
†S = equivalent plane wave power flux density.

Condition A applies in areas in which the risks of shocks and burns exist. Condition B applies when these risks have been eliminated.

While the Australian exposure limits are the same as those of both the American National Standards Institute (ANSI) and the International Radiation Protection Association (IRPA) in the 30-300 MHz band, they are five times stricter than those of ANSI and IRPA above 1,500 MHz.

The Australian standard is similar to the safety guidelines adopted by the Johns Hopkins University Applied Physics Laboratory (JHU-APL) in 1984. The JHU-APL limits are also based on the ALARA principle and are frequency-independent from 30 MHz to 100 GHz; they are stricter, however, limiting exposures to 100 uW/cm² in that frequency range (see *MWN*, December 1984).

In a "Rationale" accompanying the Australian standard, Committee TE/7 on Hazards of Non-Ionizing Radiation explained that:

> "With the present state of knowledge and taking into account the differences in opinion as to where an increase in the maximum exposure level would be appropriate, it would be wise not to increase the maximum exposure level for this higher frequency range above 1 mW/cm² at the present time."

Like IRPA's standard but unlike ANSI's, the Australian standard specifies limits for the general public which are five times more stringent than those for workers — ANSI recommends the same levels for workers and the general public. (The rationale details why its recommendations differ from those of the ANSI standard.)

Shocks and Burn Hazards Minimized

The committee that wrote the standard devised an original solution to the vexing problem of RF shocks and burns, setting different exposure limits for environments with and without such threats. For instance, when the risk of shocks and burns is present, RF exposures below 9.5 MHz are limited to 10 mW/cm², but when the necessary precautions are taken, the standard rises to 100 mW/cm² below 3 MHz.

Other key features of the Australian standard are:

- Between 300 kHz and 300 GHz, exposures can never exceed 1000 mW/cm², no matter how short the time.
- For all exposure conditions, regardless of the field strength, an averaging time of 1 minute is used.
- For exposures between 6 and 30 minutes, the limits can be relaxed by a factor of up to 5.
- Devices operating at frequencies below 1 GHz with an output power of less than 7 watts are excluded.
- Eye examinations are recommended for non-ionizing radiation workers before and after employment and at least every five years, if not more frequently.

RF Heater Workers Are Overexposed

In a paper presented at last August's *Conference of the Australian Radiation Protection Society* in Melbourne, Dr.

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UPDATES

COMMUNICATIONS

NAB Seeks Preemption... The National Association of Broadcasters (NAB) has again petitioned the FCC to preempt state and local rules on RF/MW exposure in favor of the ANSI standard, which the commission has adopted. In a March 17 filing, the NAB argued that the growing patchwork of local regulations is damaging to broadcasters and contended that "there is no rational reason to defer consideration of federal preemption." When it rejected the NAB's last plea in September, the FCC said that it was unsure of the legal basis for preemption (see *MWN*, September/October 1985). The NAB responded that the FCC has the necessary authority under both the Communications Act of 1934 and the First Amendment to the Constitution. The NAB also urged the FCC to adopt a policy statement, concluding, "Absent new scientific evidence showing potential from public exposure to [RF] energy at levels below the ANSI guidelines, the Commission believes that significantly more stringent state or local standards, which unduly restrict [broadcast and other interstate communications] services, must be preempted."...To reinforce the urgency with which it views this matter, the NAB calls non-ionizing radiation "perhaps the most important broadcasting issue of the year" in a brochure describing its engineering conference to be held April 12-16 in Las Vegas, NV.

Portland Measurements... The EPA's Richard Tell and the FCC's Dr. Robert Cleveland are scheduled to make RF measurements in Portland, OR, the week of June 23, with the week of July 14 as a backup, in case of possible conflicts. Meanwhile, the Portland City Council has deferred action on the proposed 200 uW/cm^2 safety standard until the FCC-EPA data are available (see *MWN*, November/December 1985).

RF Warning Sign

The National Association of Broadcasters (NAB) is marketing a radiofrequency (RF) radiation warning sign to help its members comply with the Federal Communications Commission's RF safety rules.

The aluminum sign, pictured below, is 24" x 18" and is printed in yellow and black: the triangle is yellow, in accordance with the specifications adopted by the American National Standards Institute in 1981 (see *MWN*, October 1981).

The signs cost $20.00 each for NAB members and $40.00 each for nonmembers. If you order three or more, you qualify for a ten percent discount. Order from NAB Services, 1771 N St., NW, Washington, DC 20036, (800) 368-5644.

COMPATIBILITY & INTERFERENCE

ARRL To Seek EMI Labeling... The American Radio Relay League (ARRL) plans to ask the FCC to require labeling of home electronic equipment to indicate susceptibility to EMI. The move was approved by the ARRL Board of Directors at its annual meeting in January. The petition, now in draft form, is under review by the Executive Committee and is scheduled to be filed in late March. David Sumner, executive vice-president of ARRL, told *Microwave News* that the petition does not grow out of any disenchantment with the ANS C63 ad hoc committee, which recently released a progress report on the immunity of TVs and VCRs (see *MWN*, January/February 1986). That report indicated that manufacturers were designing TVs and VCRS with greater immunity to EMI, but that more progress was still needed. Sumner said that the purpose of the petition was to make sure that the public is better informed about EMI problems.

Compliance Handbook...Dash, Straus & Goodhue (DS&G), an EMC R&D lab based in Boxborough, MA, has published *Compliance Engineering 1985-1986*. The 315-page volume explains how to comply with U.S. mandatory and voluntary standards for electronic equipment, as well as with many international regulations. (It covers both EMI and ESD but not U.S. military standards.) Parts 15 and 68 of the FCC rules are reviewed in great detail — including full texts of key FCC documents. According to Glen Dash, the editor of the handbook, the 15,000-copy press run is nearly exhausted, but a limited number of copies are still available. To obtain a complimentary copy or to be on the distribution list for the next edition, write to Dash at DS&G, 593 Massachusetts Ave., Boxborough, MA 01719, (617) 263-2662.

Power Conditioners... The first edition of *The Computer Power Buyers Guide* — a directory of standby power supplies, uninterruptible power supplies, power conditioners, computer grade transformers and voltage regulators — has been published by Gregory Evans. The guide lists more than 2,000 products from 70 manufacturers, giving their technical specifications and prices. Updates are planned every six months. The guide is available for $29.95, plus $3.50 shipping and handling, from Wellspring Enterprises, 9921 Carmel Mountain Rd., San Diego, CA 92129, (619) 484-4479. Telephone orders are accepted: call (619) 484-2435.

EM Shielding... Amplifier Research has introduced a new transmission-line cell, the SET-19, to test the effectiveness of RF shielding materials. The 14x5.5-inch cell helps produce "more accurate and repeatable results than those generated by shielded-room testing," according to the company. The SET-19 has an operating bandwidth of 0-3,000 MHz and costs $6,600. For more information, contact: Amplifier Research, 160 School House Rd., Souderton, PA 18964, (215) 723-8181....Carroll Coatings Co., which entered the EMI shielding market in 1983, is offering two new specialty coatings for plastics, composites and metals. Spectraguard C-621 Conductive Silver Polyurethane Coating provides a shielding effectiveness of 78 dB from 1 MHz to 3,000 MHz, while Spectraguard C-641 Conductive Silver Acrylic Coating provides a slightly lower capability (75 dB) in the same frequency range. Both coatings also eliminate static electricity buildup; the major difference between the two is that C-641 can be used for flexible applications. For more information, contact: Carroll Coatings Co., 217 Chapman St., Providence, RI 02905, (401) 781-4942.

GOVERNMENT

Keeping Up with Washington... The Gramm-Rudman budget reduction law and concern over national defense are making it more and more difficult to follow the government's activities. On February 21, the FCC stopped publishing full texts of its proposed rules, rulemaking decisions and policy statements. FCC officials said that the move to issue only summaries in the *Federal Register* was prompted by a $4 million cut in its FY86 budget under Gramm-Rudman. According to the commission, the summaries will provide sufficient details to keep the public informed. Those who want the full texts will have to go to FCC libraries or buy the documents from the FCC's contractor, International Transcription Services, 2100 M St., NW, Suite 140, Washington, DC 20037, (202) 857-3800....At the FDA, the Gramm-Rudman law is forcing the Center for Devices and Radiological Health to turn its two newsletters, the *Radiological Health Bulletin* and the *Medical Devices Bulletin*, into bimonthlies. An FDA staffer told *Microwave News* that neither publication could resume a monthly publication schedule before FY87 (which begins October 1, 1986), if then....On a different front, *Aviation Week* reported in its March 17 issue that, two years ago, the DOD and the CIA started a disinformation program on a number of key aircraft and weapons programs. Among those affected are the Strategic Defense Initiative (SDI, also known as "Star Wars") and the Stealth bomber, which is designed to evade radar detection. Under the plan, the government is releasing "deliberately false, incomplete and misleading" technical information, according to *Aviation Week*. On March 20, the *Washington Post* reported that U.S. senators were pressing for an investigation after hearing reports that members of Congress were victims of the disinformation program at the same time that SDI staffers provided Soviet officials with a classified briefing on Star Wars. At last word, a Congressional hearing has been scheduled, but it will be closed to the public.

FCC Steps Up EMI Enforcement... The FCC's FY87 budget request includes ten new positions for field operations personnel to respond to EMI complaints and to public requests for information. The commission notes that, "The rapid development of telecommunications technology resulting from deregulation has dramatically increased interference problems in a number of services, particularly the safety services." By early March, the first signs of the new enforcement policy surfaced as Richard Smith, chief of the FCC's Field Operations Bureau, announced that the commission was stepping up its efforts to stop the illegal sale and use of linear amplifiers to boost CB transmitter power. According to FCC statistics, 57 percent of the public's complaints of EMI to home electronic equipment from CB radios can be attributed to overpowered CB stations, of which 91 percent involved linear amplifiers. Smith told the Associated Press that, "People's tolerance for interference is good until it is repeated over a long period of time; you can get pretty tired of the same guy interfering with your viewing of *Dallas* every Friday."...A further signal came from the FCC's testing program of microcomputers. According to an item in the March 24 *InfoWorld*, half of 29 micros tested — all of which had previously won FCC approval — failed to meet the commission's Part 15 emission limits. The FCC's Art Wall will not reveal which company's computers were leaking too much radiation until the testing program is completed in May.

EMC LAP Moves Forward... The NBS will proceed with its new Electromagnetics Laboratory Accreditation Program (LAP) now that a dozen labs have applied for accreditation. The LAP, which covers EMC and telecommunications testing, was officially announced last September in response to a request from Retlif Testing Labs (see *MWN*, March, June and September/October 1985). According to Jeffrey Horlick, project leader for the Electromagnetics LAP, the 12 responses justify proceeding with the LAP. Horlick is planning an April workshop for four technical experts, who will be under NBS contract to evaluate applicants. Horlick now estimates that the first labs could win accreditation by September 1. For more information, contact Horlick, NVLAP, NBS, ADMIN A531, Bldg. 101, Gaithersburg, MD 20899, (301) 921-3431....In a re-

lated development, the General Services Administration has asked the NBS to set up a new LAP to accredit laboratories that provide electrical and safety testing services. Among the standards to be codified is one for EMI filters. Comments on the proposal are due by May 12. For more information, see the NBS's March 12 *Federal Register* notice (51 *FR* 8525).

Economics of Standards... The EPA's Office of Radiation Programs has issued a request for proposals for an "Economic Analysis of Radiation Protection Standards." The successful contractor will estimate the costs and benefits of a number of possible regulations, including non-ionizing radiation exposure standards for workers and the general public. Among the other standards to be studied are those associated with radon in homes, low-level radioactive wastes, uranium mill tailings and ionizing radiation in the workplace and in the general environment. Proposals were due on February 5, and the work must be completed by September 30, 1987. For more information on Solicitation No. DU-86-C038, contact the EPA's contract officer, Vickie Presnell, (919) 541-3564.

MEASUREMENT

Time-Averaging Meter... Holaday Industries, based in Eden Prairie, MN, has introduced a new measurement system that can average radiation signals over six-minute intervals and therefore monitor compliance with the ANSI standard. The HI-5000-SX system includes the HI-3002 broadband field strength meter and the HI-3320 "datalogger." Users can see instantaneous exposure levels as well as six-minute averages. The price of the whole system is $4,990; it can also be rented for $650 per month. Individually, the HI-3002 costs $3,395 and the HI-3320 costs $1,595 (including connector cable). For more information, contact Burton Gran, Holaday Industries, 14825 Martin Drive, Eden Prairie, MN 55344, (612) 934-4920....EPA's Richard Tell has prepared a paper that describes his evaluation of the HI-5000-SX system and its use for measuring fields from broadcast sources. Tell will present the paper at the National Association of Broadcasters' (NAB) Engineering Conference on April 15 in Dallas, TX. For information on obtaining a copy of the paper, contact NAB's Publications Dept., 1771 N St., NW, Washington, DC 20036, (800) 368-5644.

Methods and Standards... Drs. Bruno Weinschel and Stephen Adam, two well-known members of the IEEE community, have edited a special issue of the *Proceedings of the IEEE* (January 1986) on "Radio Measurement Methods and Standards." This impressive collection of 44 invited papers reviews not only measurement techniques, but also the analysis and interpretation of the data. Many of the authors work at the NBS, and others give the volume an international perspective. Researchers from Australia, Canada, Denmark, England, Japan and the Soviet Union are represented. The papers will probably later be turned into an IEEE Press book. Single copies of the issue are available for $6.00 (IEEE members) or $12.00 (others) from the IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854, (201) 981-0060.

In the Near Field... Arthur Yaghjian of the Electromagnetic Sciences Division at Hanscom AFB, MA, has published "An Overview of Near Field Antenna Measurements" in the January issue of the *IEEE Transactions on Antennas and Propagation*. The well-referenced paper discusses sources of experimental error and the limitations of planar, cylindrical and spherical near field scanning....Staffers at the U.S. Army's White Sands Missile Range are writing specifications for the acquisition of an "Antenna Near Field Measurement System," covering the frequency range 100 MHz to 18 GHz and later for millimeter waves. See *Commerce Business Daily*, March 14, p.64.

MEDICAL APPLICATIONS

Aberrant Heating... Hyperthermia treatments can heat normal healthy tissue, in addition to tumors. Drs. Mark Hagmann and Ronald Levin of the NIH in Bethesda, MD, have been using computer modeling to study ways of minimizing what they call "aberrant heating." They recommend avoiding 100-500 MHz, frequencies in the resonance range; their model indicates little heating outside the desired area below 60 MHz. Conversely, they note that microwave frequencies may also be desirable since the energy does not penetrate very deeply. They urge oncologists to heed complaints from patients regarding heating in various parts of the body. Their paper, "Aberrant Heating: A Problem in Regional Hyperthermia," appears in the April issue of the *IEEE Transactions on Biomedical Engineering*.

Electric Man...*Discover* magazine has discovered Dr. Bjorn Nordenstrom and his theories about the electrical network inside the human body and its role in both the development and the treatment of diseases — especially cancerous tumors. The cover of the magazine's April issue offers a generous, though tentative, appraisal: "If he's right, he has made the most profound biomedical discovery of the century." According to Nordenstrom, a Swedish radiologist based at the Karolinska Institute in Stockholm, an injury in the body creates an alternating voltage, which drives an AC circuit, with blood vessels serving as the wiring between healthy and diseased tissue. Nordenstrom has applied his theory to the treatment of lung and breast cancers: he inserts electrodes into the tumor and into the surrounding healthy tissue and applies a low-voltage electric current. Many researchers believe Nordenstrom has had impressive results. Among the 20 patients who first received the treatment, the tumors regressed in ten cases and disappeared completely in seven others. Nordenstrom has treated 80 patients so far, without any fatalities. *Discover* asks "why the medical community has barely noticed that Nordenstrom's theory exists." A 358-page book explaining his theory, *Biologically Closed Electric Circuits: Clinical, Experimental and Theoretical Evidence for an Additional*

Circulatory System, was self-published in 1983 and has sold only 400 copies. A few scientists are aware of his work, however, and research groups in France and Japan are beginning to replicate his findings....See also Nordenstrom's paper, "Biologically Closed Electric Circuits: Activation of Vascular Interstitial Closed Electric Circuits for Treatment of Inoperable Cancers," in the *Journal of Bioelectricity, 3,* pp.137-153, 1984.

MEETINGS

Static Magnetic Fields...A workshop on the *Biophysical Effects of Steady Magnetic Fields* was held in Les Houches, France, February 25-March 6. Among the participants were Drs. A. Belossi, F. Bistolfi, J. Bouvet, Klaus Dransfeld, Richard Frankel, Abe Liboff, Robert Liburdy, Peter Semm and D. Sperber. The proceedings of the workshop will be edited by Dr. G. Maret of the Max Planck Institute in Grenoble, France, and will be published by Springer-Verlag.

Electroheat... Last December 2, the Canadian Ministry of Energy and Ontario Hydro jointly sponsored a *Radiant Wave Electroheat Workshop* in Toronto. The 11 papers presented at the meeting have now been published in a typescript volume, which is available at no charge while supplies last. Contact: Gillian MacLeod, Industrial Product Development, U4-E4, Ontario Hydro, 700 University Ave., Toronto, Ontario M5G 1X6, Canada, (416) 592-5526. Please enclose a self-addressed mailing label.

MILITARY SYSTEMS

Central OTH-B... In our last issue we reported on the U.S. Air Force's plans to prepare an environmental impact statement (EIS) for a new over-the-horizon backscatter (OTH-B) radar in Alaska. In February, the Air Force announced that it was preparing another EIS for its fourth OTH-B radar, to be located in the middle of the country. The proposed sites for the transmitter and the receiver are in Minnesota, North Dakota and South Dakota. According to the current schedule, the draft EIS for the Alaska OTH-B will be completed at the end of May and the draft EIS for the central OTH-B will be ready a month later. Meanwhile, testing has begun on the East Coast OTH-B, which should be operational by the end of 1987, and, this summer, construction will begin on the west coast OTH-B. For more information, contact Colonel James Lee, OTH-B Systems Program Office, HQ Electronic Systems Division, Hanscom AFB, MA 01731, (617) 271-5387.

STANDARDS

Revising ANSI C95.1... Subcommittee IV of the Accredited Standards Committee C95 on Non-Ionizing Radiation Hazards will review a draft revision of the 1982 ANSI RF/MW radiation safety standard at a two-day meeting, June 6-7, in Madison, WI, immediately following the Bioelectromagnetics Society annual meeting. (The dates were rescheduled from May 31-June 1.) According to John Osepchuk of Raytheon, the secretary of the subcommittee, the standard is being "significantly" revised and now includes a new requirement to limit shocks and burns from induced currents at low frequencies — changes prompted by new data from the Universities of Utah and Washington (see *MWN,* July/August 1985). A working group of the subcommittee met in Las Vegas, NV, December 4-5. At that time, members of the working group were given writing assignments to prepare the draft standard for discussion in Madison.

RF/MW Safety in Eastern Europe... Dr. Przemyslaw Czerski describes current RF/MW radiation exposure standards in Czechoslovakia, Poland and the U.S.S.R. in the most recent issue of *The Journal of Microwave Power, 20,* pp.233-239, 1985. (See also *MWN,* June 1985.) Based on informal personal communications, Czerski reports that the Council of Mutual Economic Cooperation (COMECON) is developing occupational guidelines to be adopted by member nations. He predicts that these levels will be similar to those adopted by the International Radiation Protection Association (see *MWN,* March 1984) and that they will depend on frequency and duration of exposure.

Electrosurgical Devices... The Association for the Advancement of Medical Instrumentation (AAMI) has issued a draft standard, *Electrosurgical Devices,* for public review. It covers generators, electrodes and cables which are designed to deliver RF and electrical currents for surgical applications. The standard was issued for comment in 1985, but has now been re-released after substantial revisions. Copies are available for $15.00 (AAMI members) or $20.00 (others), prepaid, plus $3.00 postage and handling, from Dawn Boots, AAMI, 1901 North Fort Myer Dr., Suite 602, Arlington, VA 22209, (703) 525-4890. Order No. HF18.

VDTs

X-Ray Emissions... Researchers at the New York University Medical Center in New York City have confirmed the findings of many other groups: almost no X-radiation is emitted by a properly built cathode ray tube (CRT). Drs. Mark Maiello, Frank Rosenthal and Naomi Harley of the university's Institute of Environmental Medicine report that operator exposures are "due to natural radioactivity and not to low-energy X-rays penetrating the tube face." Their paper appears in the February 1986 issue of *Health Physics.*

Pregnancy Risks Resources...NIOSH officials have verified a reported miscarriage cluster among VDT operators at the Alma, MI, office of the General Telephone Co. of Michigan. The report on the agency's findings cautions that the study population was too small to make the association statistically significant, however. The report, HETA 84-297-1609, is available from NIOSH, Division of Standards Development and Technology Transfer, 4676 Co-

lumbia Parkway, Cincinnati, OH 45226....A Finnish research team led by Dr. Kari Kurppa has published the final results of its epidemiological study of birth defects and VDT work (see *MWN*, January/February 1985). The study, which found no evidence that terminal operators face an increased risk of giving birth to children with defects, appears in the *Scandinavian Journal of Work and Environmental Health, 11,* pp.353-356, 1985....Officials at Health and Welfare Canada (HWC) have dismissed the conclusions reached by Dr. Hari Sharma in his report on a cluster of problem pregnancies at the Surrey Memorial Hospital in Vancouver, BC (see *MWN*, July/August 1982 and October 1984). Sharma judged that the cluster was most likely caused by non-ionizing radiation from VDTs. In their critique, HWC's Drs. S. Mohanna and Maria Stuchly, of the Radiation Protection Bureau, and Dr. G.J. Sherman of the Bureau of Epidemiology argue that Sharma's findings are "distorted and not based on scientific evidence."...In a related development, in December the Health Protection Branch of HWC sent an "Information Letter" to Canadian physicians, assuring them that VDT radiation poses no risk to terminal users. Copies of both documents are available from the Radiation Protection Bureau, HWC, 775 Brookfield Road, Ottawa, Ontario K1A 1C1, Canada.

From the UK... Humane Technology, a consulting group, has published the proceedings of a meeting on VDTs it held late last year. *A Conference on the Alleged Health Hazards of Work at VDUs: Current Industrial Relations Issues* includes 15 papers from labor, business and academic groups in the UK, covering reproductive risks, repetitive strain injuries and other musculoskeletal ailments. It is available for 17.50 Pounds (16.00 Pounds in Europe) from Humane Technology, PO Box 2, Quorn, Leicestershire LE12 8EG, UK....The British government's Health and Safety Executive (HSE) has released a ten-page pamphlet, in a question-and-answer format, that dismisses concerns about radiation emissions, reproductive risks and other long-term VDT health problems. *Working With VDUs* is available for free from the HSE, Baynard House, 1 Chepstow Place, Westbourne Grove, London W2 4TF, UK....The London-based Trades Union Congress (TUC) has reprinted labor union negotiating guidelines issued last year by FIET, the International Federation of Commercial, Clerical, Professional and Technical Employees. The *TUC Guidelines on VDUs*, covering radiation emissions, reproductive risks and visual and musculoskeletal problems, is available for 1.20 Pounds from the TUC, Congress House, Great Russell Street, London WC1B 3LS, UK.

ETC...

Units and Terminology... The International Non-Ionizing Radiation Committee (INIRC) of the International Radiation Protection Association (IRPA) is trying to bring a modicum of uniformity and harmony to the field. To this end, an INIRC working group has published a "Review of Concepts, Quantities, Units and Terminology for Non-Ionizing Radiation Protection." It covers ELF, RF, MW and optical radiation, as well as ultrasound. The working group's report, which includes a host of useful definitions and explanations and an index of quantities and units, appears in the December 1985 issue of *Health Physics*.

Odds and Ends...A team of German and Australian scientists have established that the platypus can locate and avoid objects using its sensitivity to DC fields. This is the first time electroreception has been shown in higher vertebrates; see the cover story in the January 30 *Nature*....In past issues, we have described the problem of winter depression and its treatment with bright lights. Now comes a report that the the suffering may not let up in the summer. An item in the March 8 *Science News* notes that researchers have found that summer symptoms include impulsive and violent behavior. Indeed, one expert is quoted as saying that seasonal swings are sometimes diagnosed as manic depression....Dr. David Carpenter, who has led the New York State research program on power line health effects, has been appointed dean of the School of Public Health Sciences of the State University of New York in Albany....And Dr. C.K. Chou, who was at the University of Washington in Seattle for 14 years, largely working with Dr. Bill Guy, has joined the City of Hope National Medical Center in Duarte, CA, as the head of biomedical engineering. Chou reports that he is starting a new hyperthermia program there....Last September, a high school student in Piscataway, NJ, died suddenly, apparently while making a phone call during a thunderstorm. The February 16 *New York Times* reports that investigators have concluded that the youth was electrocuted by a lightning-induced surge on the phone line, which caused his heart to stop....The stealth bomber, designed to be invisible to radar, has gained a conspicuous presence in Washington over the last few months. In a series of columns, Jack Anderson has berated the stealth bomber program as an expensive failure: the bombers may cost up to $80 billion and may still be detectable by older Soviet radars. See also the cover story in the February *Discover* magazine....The Polytechnic Institute in Brooklyn, NY, has honored Dr. Ernst Weber by renaming Poly's Microwave Research Institute as the Weber Research Institute....The March 12 *Washington Post* Health Section cites research by Larry VandeCreek of Ohio State University that shows that stress-induced stomach "butterflies" are caused by electrical activity....On March 28, UPI reported that a jury awarded more than $1 million to a woman who alleged that she had lost her psychic power after having a CAT scan. The hospital is appealing the decision....And finally, there is the case of Bruce Blair, a staffer at the Congressional Office of Technology Assessment (OTA) who wrote a report on the vulnerability of military communications to nuclear weapons, such as EMP radiation. According to the February 18 *Wall Street Journal*, he did his job too well — his OTA report was classified ultrasecret, and Blair can no longer read it, even with his top-secret clearance.

FROM THE FIELD

NAS-NRC: DOE's Research Program on EMF Safety

Excerpted below is the chapter on the safety of electric and magnetic fields (EMF) from the National Academy of Sciences (NAS) - National Research Council's (NRC) Issues in Electric Energy Systems: A Review of the DOE R&D Program. *The report was prepared by the Committee on Electric Energy Systems (EES), chaired by Andrew Corry, retired from the Boston Edison Co., and published by the National Academy Press. It was requested by the Department of Energy (DOE). To aid in its work, the committee held a two-day workshop last April which was closed to the public. A number of experts on EMF bioeffects were invited to present their views (see* MWN, *March 1985). Among the members of the committee with a special interest in EMFs are Drs. David Carpenter of the New York State Department of Health and Michael Marron of the Office of Naval Research. Copies of the full report and of the proceedings of the workshop,* Papers Presented at a Workshop on Electric Energy Systems Research, *are available for $5.00 each from the Energy Engineering Board, NRC, 2101 Constitution Ave., NW, Washington, DC 20418.*

BACKGROUND

...The impacts of EMF fields at the levels induced by transmission lines are not well understood. Unfortunately, there is a wide body of conflicting literature alleging that the effects on biological systems of EMF at levels induced by transmission lines range from the nonexistent to the catastrophic.

The physical effects of EMF induced by transmission lines include audible noise and radio and television interference. Certain types of pacemakers can be adversely affected by exposure to these fields. With respect to biological effects, it is known that bees in hives may experience physiological and behavioral problems in the presence of EMF fields and that cattle may experience small shocks from induced voltages picked up by ungrounded metallic objects.

Numerous investigators have attempted to determine to what extent the electrical and magnetic environment produced by transmission of electrical energy poses a health hazard to living organisms. Effects on the nervous system have been convincingly demonstrated in laboratory animals. The effects include altered neuronal excitability, altered levels of certain hormones affecting circadian rhythms, behavioral changes, and altered locomotor activity. It is not yet known whether these and other observed effects are caused by a direct interaction of the electric field with tissue or an indirect interaction, such as a physiological response caused by sensory perception of the fields by test animals. The nature of the physical mechanisms involved in field-induced effects is obscure and is one of the most important goals of current research.

Based on the evidence examined, including the papers presented at the Workshop, the Committee believes that much of the literature claiming that EMF is hazardous fails to meet such criteria for objective scientific research as proper experimental controls and replicability of results.

The public at large has a serious and legitimate concern for the safety of electric power facilities and does not have the information and the criteria to make scientific judgments on its own. The literature on biological testing for the full range of potential effects posed by EMF is incomplete, leaving many questions unanswered. As a result, persons and organizations who sincerely believe in the harmful scenarios can take legal action either to prevent or to slow down the construction of new transmission and distribution facilities on the grounds that harmlessness cannot be proved. These actions, if successful, can add significant costs to both the construction of new facilities and to the operation of the electric power system, and can prevent needed expansion to improve reliability and economy of service.

Unfortunately, it is impossible to prove in an absolute sense that an environmental agent such as EMF has no harmful effects under any and all circumstances. However, it is possible to provide a baseline of highly qualified research, specifically designed with electric power systems in mind, that would increase the understanding of the phenomena and would contribute to higher confidence levels for planners and builders of transmission facilities. Some of this work is being done by EPRI ($15 million is to be spent between 1985 and 1989), but however high its scientific quality may be, it will of itself not be adequate. To begin with, there is the problem of policy credibility when a party at interest sponsors the research. In addition the level of funding is limited and cannot be expected to cover all relevant research problems. Thus, additional effort is needed both to evaluate and confirm EPRI's efforts independently as well as to add to the total pool of original investigation.

COMMITTEE FINDINGS

Recommended Research Program

An EES-sponsored research program aimed at addressing potential health hazards of AC and DC transmission lines should include both a long-term basic research component and a short-term applied research component. The objective of the short-term component should be to provide an adequate basis for establishing reasonable exposure guidelines. This program should involve an intense effort focused on established effects and should be aimed at determining dose-response curves for biological effects. A second part of the program should be aimed at developing a dosimetric basis for extrapolating results from animal studies to equivalent exposures in humans. A third and final part of the short-term program should involve epidemiological research. Planning for a careful program of epidemiological studies of transmission line field health effects should begin immediately because lack of data may impede new transmission line projects.

The Committee envisions a short-term component funded at a level of $10 million a year and lasting approximately five years. This research should lead to agreement on an appropriate index for establishing exposure standards. It must be recognized that such a standard will require periodic review and revision as information becomes available about the mechanisms by which electric and magnetic fields alter biological functions.

The long-term basic research component of this program should have as its objective the determination of mechanisms between electric and magnetic fields and biological tissue. A firm understanding of these mechanisms of interaction is required for reliable extrapolation to humans of laboratory studies of field effects on animals.

The Committee envisions a long-term program funded at a level of approximately $2 million a year conducted over a period of ten or more years. The exact length of time necessary for the conduct of this basic research is difficult to estimate.

Experience in the study of the biological effects of ionizing radiation suggests that even after the mechanisms of interaction

are known, additional research will be required to address questions about the hazards of chronic exposure to very low level fields.

Critique of DOE's Current EMF Efforts

If the combined program of basic and applied research is to have any impact on the question of biological effects of transmission line fields, it is essential that funding and management of the program develop far greater stability than has existed in the past at DOE.

This research has frequently suffered from poor definition of priorities, unstable funding, lack of competition and peer-reviewed analysis of proposals, mediocre quality of investigators, inadequate dosimetry of fields, and lack of solid scientific approach to the questions requiring double-blinded exposures, dose-response studies for effects, and tests for reproducibility of results. The result is that the field is cluttered with reports drawing conclusions of questionable validity.

It is critical that the DOE program be directed by a staff that is knowledgeable about both the biological and engineering aspects of exposures to electric and magnetic fields. For the program to be competitive the investigators selected should be of the highest quality. A system of peer review for research proposals is necessary: lack of adequate peer review has contributed to the perception of the current program as limited and unimaginative. The tendency to fund current contractors whose special EMF effects capabilities may be less than desired for work in such new areas, while offering some advantages in administration of the program, severely limits its vitality and is certain to lead to ultimate failure in the adequate identification of the causes and extent of field effects on humans.

In the view of the Committee, the administration of these programs by DOE has been far below standard. This may not reflect on the persons currently responsible for administering the program, but rather the lack of specialized personnel, the instability of the funding, and other factors beyond their control.

Whatever the reasons, the result has been a program that has marginal credibility and may not have supported the most competent investigators. It is critical that this program be competitive and that contract awards be made by a peer review process on the basis only of the quality of the application and the ability of the applicant. For the program to be successful and to avoid the past difficulties, it is critical that it be directed by a staff that is knowledgeable about both the biological and engineering aspects of EMF exposure. This administrative group within DOE should be enlarged to include biologists as well as engineers.

Proper Place of the Program

While the Committee agrees on the need for a federal program of research to address issues of the safety of power transmission lines, it is not obvious where such a program should reside. The National Institutes of Health (NIH) are responsible for several programs concerned with health and human safety. However, they are not highly directed to the specific problems of the power industry and are unlikely to give the problems adequate priority. For this reason NIH is probably an inappropriate choice. Agencies with regulatory responsibility in areas including radiation and field effects (the Environmental Protection Agency and the National Institute for Occupational Safety and Health) should maintain a research program of sufficient breadth to permit intelligent exercise of that responsibility, but they cannot be expected to undertake the role of developing the specific scientific basis for regulation with respect to the electric power industry.

DOE is the most logical agency to assume responsibility for support of basic research necessary to establish exposure standards related to the electric supply system. DOE historically has assumed this responsibility and has in the past initiated a program of research on health effects of AC transmission line electric fields. Although the nature of the program and the location of responsibility for it within the organization [have] changed many times over the years, DOE has remained and should remain the major funding organization for research into the health effects of transmission line fields.

Australian RF/MW Standard

(continued from p.6)

K.H. Joyner of the Australian Radiation Laboratory noted that, "Implementation of the new standard will undoubtedly require surveys of existing facilities to be carried out. Subsequent to these surveys, and where necessary, changes to work practices and/or alteration to these facilities, such as the installation of shielding, will have to be made."

Indeed, Joyner and his colleague, Dr. M.J. Bangay, have found, in a survey of the electric and magnetic fields near 101 RF heaters, that 39 percent of the units exposed the operators to levels greater than the 1985 limits — up to ten times the standard — and that 23 percent of the heaters exposed the operators to levels that were at least ten times greater than the standard. The survey results were published in the March 1986 issue of *Health Physics*.

The Australian standard had been under development since 1978. In 1982, occupational limits identical to ANSI's were proposed, with public exposure limits ten times stricter. That proposal was opposed by the Australian Council of Trade Unions (see *MWN*, April and May 1983).

A copy of Australian Standard AS 2772-1985, *Maximum Exposure Levels – Radiofrequency Radiation – 300 kHz to 300 GHz*, is available in the U.S. for $15.00, plus $4.00 shipping and handling, from the ANSI Sales Office, 1430 Broadway, New York, NY 10018, (212) 642-4900. Orders must be prepaid. In Canada, the standard is sold by the Standards Council of Canada and in the U.K. by the British Standards Institution. It is also available directly from the Standards Association of Australia, PO Box 458, North Sydney 2060, Australia.

See also two papers that discuss the standard: "Overview and International Approaches to Radiofrequency Radiation Exposure Standards" by T.N. Swindon and "The Australian Radiofrequency Exposure Standard: Implications and Implementation" by K.H. Joyner (cited above), both published in *Radiation Protection in Australia, 3*, pp.119-121 (No.3) and pp.135-140 (No.4), respectively.

ELF Teratology (continued from p.1)

"You're doing the wrong study," Phillips told Newell. "All data since 1975 conclusively show that exposure *in utero* is not teratogenic. If you have to do a study to clear the air, do the right one."

Newell responded that EPRI had asked three "eminent" teratologists to analyze the Battelle data and they had concluded that, due to the "variability and inconsistency in the results," it was not worth another $1-2 million to explore multi-generational teratological effects. This exchange took place in Alexandria, VA, at the annual review of contractors doing research on the bioeffects of transmission lines for the Department of Energy, EPRI and New York State.

Anderson, who replaced Phillips as head of the electric field effects program at Battelle, said in an interview that Battelle had originally proposed a multi-generation exposure study, but had been turned down by EPRI.

In a telephone interview, Dr. Leonard Sagan, a senior scientist at EPRI, told *Microwave News* that Phillips had convinced EPRI to do long-term studies. "Newell's arm was twisted," he said, because "Phillips made a good point and we respect him." In 1984 Phillips left Battelle to join the Environmental Protection Agency in Research Triangle Park, NC.

Sagan added that the original decision to do only short-term studies was based on the fact that the experimental designs of the swine and rat studies were complex and different from other, more traditional, teratological studies.

The Swine Study

The swine study was designed to screen for a broad range of biological end points. Three generations of miniature swine were exposed to 30 kV/m 60 Hz fields. (The diagram below explains the design of the study; note that "farrow" means to "give birth.") Most of the results indicated no ill effects associated with ELF exposure. Adverse effects showed up only among the F1 females that were born and bred in the field, among their offspring (F2) and among the offspring of the Fo females that were rebred after being exposed for 18 months.

The significant effects were:

- Increased number of live fetuses per litter (fewer prenatal deaths) in the first breeding of Fo females, exposed for four months, compared to sham-exposed controls [Fo'];
- Increased incidence of morphological malformations and lower body weights among fetuses from exposed Fo females rebred at 18 months of exposure;
- Impaired mating performance of exposed F1 females bred at 18 months of exposure; and
- Increased incidence of birth defects and lower weights among offspring from F1 pigs bred at 18 months of exposure.

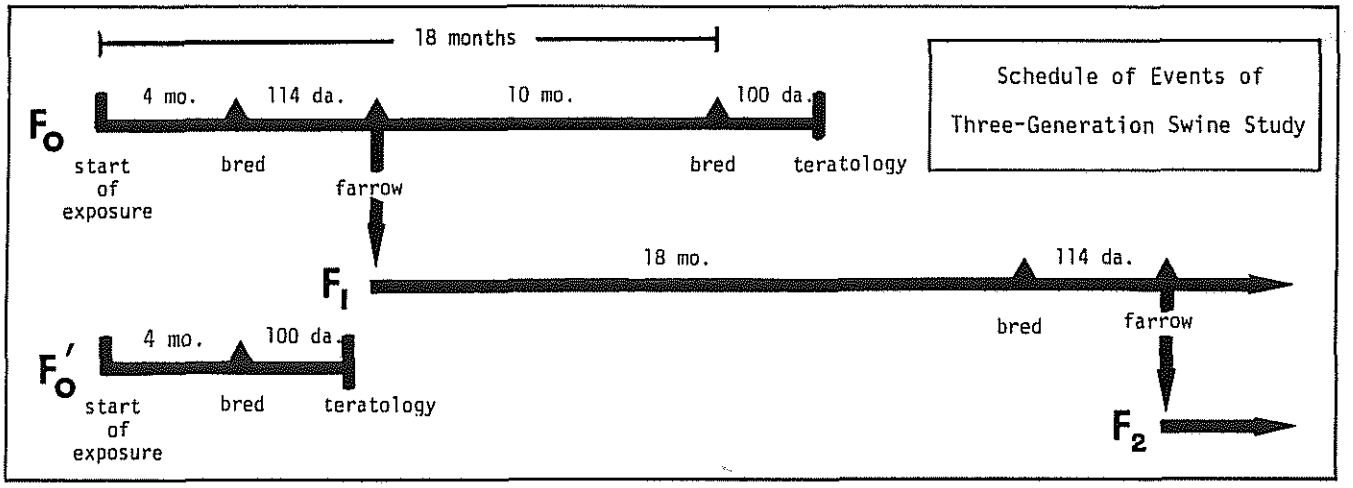
The experiments took six years to complete, and although the study was finished in early 1982, the results were not published until late 1985. Informed sources told *Microwave News* that EPRI caused the delays by repeatedly insisting on revisions in Battelle's final report.

Marino-Becker Studies

The Battelle-EPRI studies support the results of two mice studies by Drs. Andrew Marino and Robert Becker, run in Becker's lab at the VA Medical Center in Syracuse, NY, in the mid-1970s.

Marino and Becker found that mice continuously exposed to 60 Hz 3.5-10 kV/m electric fields gave birth to pups that had lower body weights and increased mortality rates. The effect was largest in the second and third generations (see *Experientia, 32,* pp.565-566, 1976, and *36,* pp.309-311, 1980).

At the time, the experiments were controversial and, later, were partly responsible for the establishment of the $5 million New York state power line bioeffects research project. A new book, *The Electric Wilderness,* by Marino and Joel Ray, describes Marino and Becker's participation in state hearings on a then proposed 765 kV power line from Canada through New York state. (The book is available for $18.75 from the San Francisco Press, PO Box 6800, San Francisco, CA 94101.)



The Rat Study

The subsequent rat study followed the same experimental design, though the exposure times were shorter: the Battelle researchers exposed the rats to an effective 60 Hz electric field of 65 kV/m for 20 hours a day. The first time the experiment was run, it revealed a teratological effect among the rat pups of females born and raised in the field similar to that identified among the miniature swine. But when this experiment was repeated, the effect did not show up.

In addition, like the swine, the F0 generation of rats showed an increase in malformations on rebreeding approximately three months after the first litters were born — this effect was significant only at the 0.12 level. Here again, when the experiment was repeated, there was no difference between the offspring of the exposed rats and those of the controls.

According to Phillips and coworkers, "The fact that the significant effects seen in the first [rat] experiment were not seen in the second may be attributed to random or biological variations, but, alternatively, may suggest that the response threshold lies at about this field strength." This conclusion was presented at the *23rd Hanford Life Sciences Symposium: Interaction of Biological Systems with Static and ELF Electric and Magnetic Fields*, held in Richland, WA, in October 1984, and will be published in the symposium proceedings, now in preparation.

EPRI Project Manager Dr. Robert Patterson characterized the rat study results as "inconclusive and suggestive" in a short review published in the June 1985 issue of the *EPRI Journal*.

The new long-term rat studies will be done simultaneously by Battelle and by the IIT Research Institute (IITRI) in Chicago, IL, using identical protocols and equipment. Anderson will be the principal investigator at Battelle and Dr. James Gerhart will lead the IITRI project.

EPRI's Newell told *Microwave News* that groups of 65-80 rats will be exposed to 10, 70 and 140 kV/m for 20 hours a day. A fourth goup will serve as controls.

Papers describing the swine and rat study results have been submitted to *Bioelectromagnetics*. EPRI has published a seven-volume report on the swine study that covers behavior (No.2); exposure and dosimetry (No.3); growth, reproduction and development (No.4); hematology and serum chemistry (No.5); immunology (No.6), and neurology (No.7), as well as a summary volume (No.1). The seven-volume report, *Biological Studies of Swine Exposed to 60 Hz Electric Fields* (EA-4318), is available for $197.50. Individually, Volumes 1, 5 and 7 cost $32.50; the others are $25.00 each. Order from Research Reports Center, Box 50490, Palo Alto, CA 94303, (415) 965-4081.

Walkie-Talkie RFI *(continued from p.1)*

Weiss cautioned that neither the agency nor the operating utilities verified the causes of the interference problems. Nevertheless, he said that the incidents were similar to numerous others already reported.

The nuclear plant RFI problem emerged in 1982 when false instrument readings indicated that an explosive bubble of hydrogen and hydrocarbons had formed inside the damaged Three Mile Island reactor No.2 in Pennsylvania. The error was later traced to RFI to the gas meter from portable radio units in the safety suits worn by the decontamination crew (see *MWN*, March 1982).

In December 1983, the NRC sent a notice to utilities that operate nuclear plants, advising them about on-site RFI. The agency warned that "the vulnerability of safety systems and nonsafety systems to inadvertent actuation or malfunction poses a significant threat to safe operation of the plant if the measures to prevent use of radio transmitters fail under emergency situations."

Though the NRC did not require utilities to "harden" their equipment, it suggested that they modify procedures to prohibit the use of radios near vulnerable devices. The notice also stated that the NRC has not adopted formal RFI protection standards and will not require further corrective action or changes in nuclear plant design.

Recent Incidents

At Palo Verde, an automatic safety system shut down unit No.1 on October 3, 1985, following the total loss of offsite power — apparently caused by a malfunction of the multiplexer in the plant's switchyard. Four days later, while the unit was not operating, the multiplexer again failed. Although walkie-talkies were blamed, Arizona Public Service, which operates the plant, did not provide the NRC with detailed information on the frequency or output power of the offending walkie-talkies. After the incidents, the utility protected the sensitive equipment.

On January 1, 1986, the River Bend plant also suffered a total loss of offsite power when two transformers were accidentally turned off; an hour later, two other transformers were also tripped. In a March 10 memo, the NRC said that two hand-held radios — one operating at 150 MHz and 4 watts and the other at 450 MHz and 5 watts — caused the trips when they were activated within 12 feet of the fiber optics systems' transceivers.

The 1983 NRC notice to utilities also listed RFI incidents at Grand Gulf, MS, Sequoyah, TN, and Farley, GA, as well as at Three Mile Island, PA. The NRC explained that solid state devices in newer nuclear plants are more susceptible to interference than the vacuum tube technology in older plants. The commission cautioned that "more cases of RFI by portable radio transmitters are likely," as old plants are retrofitted with solid state equipment.

To obtain copies of the two NRC memos — *IE Information Notice No.83-83: Use of Portable Radio Transmitters Inside Nuclear Power Plants* and *IE Information Notice No.86-15: Loss of Offsite Power Caused by Problems in Fiber Optics Systems* — write to the NRC, Public Document Room, Washington, DC 20555.

CONFERENCES

New Listings

June 5-6: **27th Conference of the Automatic RF Techniques Group (ARFTG),** Sheraton Inner Harbor Hotel, Baltimore, MD. Contact: Richard Irwin, Systems for Automatic Test, 1292 Reamwood Ave., Sunnyvale, CA 94089, (408) 734-9447.

July 28-August 1: **URSI Open Symposium on Wave Propagation: Remote Sensing and Communications,** University of New Hampshire, Durham, NH. Contact: Prof. Robert Crane, Thayer School of Engineering, Dartmouth College, Hanover, NH 03755.

August 4-8: **Gordon Conference on Magnetic Resonance in Biology and Medicine,** Tilton School, NH. See *Science* March 7, p.1180.

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

August 27-September 4: **International Conference on Large High-Voltage Electric Systems,** ASSAS University, Paris, France. Contact: CIGRE, 112 Blvd. Haussmann, 75008 Paris, France, (1) 45-22-65-12.

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

September 23-25: **8th Annual Meeting and Symposium of the Antenna Measurement Techniques Association,** Westin Hotel, Ottawa, ONT, Canada. Contact: Laurier Forget, National Research Council, Ottawa, Ontario K1A 0R6, Canada, (613) 993-9009.

March 3-5, 1987: **7th International Symposium & Technical Exhibition on Electromagnetic Compatibility,** Zurich, Switzerland. Contact: Prof. T. Dvorak, ETH Zentrum-IKT, 8092 Zurich, Switzerland, (1) 256-2790, or Prof. Ralph Showers, Dept. of Electrical Engineering, University of Pennsylvania, Philadelphia, PA 19104, (215) 898-8123.

Upcoming Meetings

May 12-15: **International Scientific Conference: Work with Display Units,** Stockholm, Sweden. Contact: WWDU, c/o Stockholm Convention Bureau, Box 1617, S-111 86 Stockholm, Sweden.

May 13-15: **2nd Annual Meeting of the Electromagnetic Energy Policy Alliance (EEPA),** Ramada Renaissance Hotel, Washington, DC. Contact: Richard Ekfelt, EEPA, 1255 23rd St., NW, Washington, DC 20037, (202) 452-1070.

May 19-22: **18th Annual Meeting of the Conference of Radiation Control Program Directors (CRCPD),** Charleston, WV. Contact: CRCPD, 71 Fountain Pl., Frankfort, KY 40601, (502) 227-4543.

May 19-24: **1986 Nuclear EMP Meeting,** University of New Mexico, Albuquerque, NM. Contact: C.W. Jones, Dikewood Corp., 1613 University Blvd., NE, Albuquerque, NM 87102.

June 1-5: **8th Annual Meeting of the Bioelectromagnetics Society (BEMS),** University of Wisconsin, Madison, WI. Contact: BEMS, PO Box 3729, Gaithersburg, MD 20878, (301) 948-5530.

June 2-4: **1986 IEEE MTT-S International Microwave Symposium,** Baltimore, MD. Contact: Marvin Cohn, c/o LRW Associates, 1218 Balfour Dr., Arnold, MD 21012.

June 8-13: **Gordon Conference on Bioelectrochemistry,** Plymouth State College, NH. Contact: Prof. Howard Wachtel, University of Colorado, Boulder, CO 80309, (303) 492-7327, or Prof. Betty Sisken, University of Kentucky, Lexington, KY 40506, (606) 258-5796. See also *Science,* March 7, p.1166.

June 16-19: **EMC Expo 1986,** Sheraton Washington Hotel, Washington, DC. Contact: EMC Expo 86, Star Route 625, PO Box D, Gainesville, VA 22065, (703) 347-0030.

June 23-27: **Conference on Precision Electromagnetic Measurements (CPEM'86),** National Bureau of Standards (NBS), Gaithersburg, MD. Contact: Norman Belecki, B146 Metrology Bldg., NBS, Gaithersburg, MD 20899, (301) 921-2715.

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