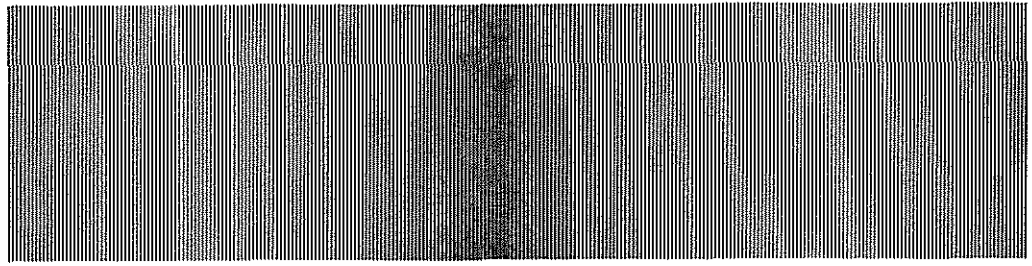


# MICRO WAVE NEWS



Vol. III No. 1

A Monthly Report on Non-Ionizing Radiation

January/February 1983

## INSIDE...

ERMAC Fades Away p. 2  
NIOSH in Disarray p. 2

## HIGHLIGHTS pp. 3-5

EPA Moves Forward on  
RF/MW Exposure Guidance

Canadian Group Recommends Limits  
for VLF Radiation from VDTs

NBS Designs New Meter to Measure  
E- and H-Fields in Near Field

Wertheimer Extends Cancer Study  
to Adults

ITT Settles Engell Suit

## SHORT COURSES p. 8

## UPDATES pp. 5-8

Biological Effects  
Communications  
Compatibility & Interference  
EMP  
Government  
International  
Measurement  
Medical Applications  
Ovens  
Power Lines  
Satellite Communications  
VDTs

---

Microwave News invites letters from readers. We ask writers to be brief, and we reserve the right to edit contributions for length.

---

## EPA Set to Close RF/MW Research Lab

The Environmental Protection Agency (EPA) is planning to close down the radio-frequency and microwave (RF/MW) radiation program at the agency's Health Effects Research Laboratory. EPA Administrator Anne Gorsuch did not request any funds for the program in her fiscal year (FY) 1984 budget, and unless Congress forces a change, all EPA research on RF/MW radiation will stop on September 30.

As this issue goes to press, the official budget has yet to be released by the President; nevertheless, most researchers contacted by *Microwave News* had already heard about the decision and expressed their dismay and disappointment. EPA staff refused to comment until the budget was made public.

The cut back comes at an inopportune time. EPA's Office of Radiation Programs (ORP) has just officially announced its intention to set a safety level, or "guidance," for public exposures to RF/MW radiation (see p. 3). The lab, which is part of EPA's Office of Research and Development (ORD) in Research Triangle Park, NC, was

---

*EPA is not the only federal agency whose non-ionizing radiation program is in trouble: NIOSH has lost much of its staff as it closed its Rockville offices, and NTIA has let ERMAC's charter expire and has ended its role in coordinating federal RF/MW bioeffects research. See p. 2.*

---

to have supported that effort. In addition, cuts in this year's (FY83) budget have already forced a reduction in many research programs at EPA and other federal agencies.

The RF/MW research group's FY83 budget is \$1.5 million, compared with \$2.12 million in FY82. ORP's budget, which includes both ionizing and non-ionizing radiation activities is slated to stay at its FY83 level, approximately \$10 million.

The EPA R&D effort represents about 15 percent of the federal budget for non-ionizing radiation research, of which more than 60 percent is controlled by the military, primarily by the air force and the navy.

EPA's research budget will be the subject of congressional hearings tentatively scheduled for March 2, 9 and 16 by the subcommittee on natural resources, agriculture research and environment of the House Committee on Science and Technology. Tony Clark, a consultant to the subcommittee, said "you can be assured that the budget cuts will be addressed at the hearing." Representative James Scheuer (D-NY) is the chairman of the subcommittee.

Last summer, Kathleen Bennett, EPA's assistant administrator for air, noise  
*(continued on p. 2)*

## Computer RFI

Many computer users are experiencing problems caused by radiofrequency interference (RFI). In the course of checking out these complaints, we have contacted a number of computer manufacturers; they respond that computer susceptibility to RFI is rare and not a general problem. We invite our readers to send us reports about specific incidents and solutions so that we can sort this situation out.

## ***EPA to Close Lab*** (continued from p. 1)

and radiation, made a strong case for the continued funding of the RF/MW research group. In a memo to Courtney Riordan, the acting assistant administrator for R&D, Bennett argued that her staff at ORP would need the help of the health effects research team in the development of the public health guidance through FY89. Even once a public limit is issued in FY85, Bennett wrote, EPA will still have to address a number of important issues such as mechanisms, modulation, chronic exposures and frequency specific effects. (The full text of Bennett's memo appears below.)

Paradoxically, the announcement that the RF/MW lab is scheduled to be disbanded comes only a few weeks after a peer review committee issued a glowing assessment of its work. In its report, the committee wrote: EPA RF/MW research is "of high quality and is highly regarded by peers in the scientific and engineering community. The breadth of expertise in the division is impressive." They cite "the excellent leadership and scientific competence" of the acting head of the lab's division, Dr. Joe Elder. The committee's members were Professor Carl Durney of the University of Utah (chairman), Dr. Elliot Postow of the Naval Medical R&D Command and Dr. Don Justesen of the VA Medical Center in Kansas City, MO.

One of the projects to be terminated when the lab closes is Dr. Carl Blackman's experiments on the effects of ELF modulated fields on calcium efflux in the brain. The review committee singled out this work as being "of immense potential significance in the determination of safety standards and in establishing a sound scientific basis for such standards."

In a telephone interview with the members of the peer review panel, all three expressed their disappointment with EPA's decision. "We need that kind of research and I will be sorry to see it go," said Durney. "The whole area is headed for extinction unless something is done... I am alarmed," said Justesen. ●

---

### **Memorandum from Kathleen M. Bennett, Assistant Administrator for Air, Noise, and Radiation, to Courtney Riordan, Acting Assistant Administrator for Research and Development, on Non-ionizing Radiation Research Needs.**

I am writing to document the research activities we will need from the Office of Research and Development (ORD) to support our regulatory program for non-ionizing radiation.

Over the next few years (FY84-85) we will be developing guidance to control the radiofrequency exposure of the public. We will need the continued support of the health effects research staff to evaluate new research results through the public comment period. More importantly, the guidance we are developing will not address such important areas as mechanisms, inhomogeneous absorption, modulation, population sensitivity, chronic low-level exposure and frequency specific effects. Research in these areas needs to begin now so that you can address these issues in a major revision of the health effects document in support of our reevaluation of the radiofrequency guidance in FY89.

We also need your assistance in reaching decisions on the need for regulation at frequencies not covered by the guidance we are now developing, i.e., for frequencies above 100 gigahertz (GHz) and frequencies below 10 kilohertz (kHz), especially at 60 hertz (Hz), the frequency used for high voltage power transmission. This is a critical area, since the trend is to higher transmission voltages and effects are now seen in animals at levels very near those produced by present transmission voltages. We need an evaluation of effects, definition of uncertainties, and research to resolve these uncertainties.

The technological advances in the use of the electromagnetic spectrum are rapid and to a great extent unpredictable. As the spectrum becomes crowded, pressures mount to move to higher and higher frequencies and different applications. We do not perceive that the issuance of guidance for

radiofrequencies in FY85 will reduce the support we need from ORD to make regulatory decisions at higher and lower frequencies or to reevaluate guidance for issuance in FY89. The health effects research staff is the only source of support we have tracking and evaluating research results and for conducting an integrated (intramural and extramural) research program to resolve important issues.

---

## ***ERMAC Fades Away***

The charter of the Electromagnetic Radiation Management Advisory Council (ERMAC) expired on January 9 and the National Telecommunications and Information Administration (NTIA), its parent agency, has made no move to renew it. NTIA head Bernard Wunder said that he has not yet decided ERMAC's future.

The agency did not request any money in its fiscal year 1983 budget for the coordination of federal research on the biological effects of non-ionizing radiation, bringing this work to a stop last October 1. Because no other agency has stepped forward to take over ERMAC from NTIA, the council may cease to exist.

Janet Healer, NTIA's program manager for non-ionizing radiation activities and an ERMAC member since its creation in 1968, has been temporarily assigned to other duties at NTIA.

ERMAC's sister committee, the Frequency Management Advisory Council (FMAC) will be renewed. Donald Jansky, associate administrator of NTIA and FMAC chairman has resigned to open up his own consulting firm. Jansky served as ERMAC's chairman at its last two meetings and had tried to find funds to allow its continued operation. ●

---

## ***NIOSH in Disarray***

The Rockville staff of the National Institute for Occupational Safety and Health (NIOSH) has dispersed. Just before Christmas, a congressional ban on moving NIOSH personnel out of the Washington, DC, area was revoked: employees were given 30 days to report to their new offices in Atlanta, GA, or Cincinnati, OH. Most refused to be reassigned. The resulting upheaval promises to further delay the completion of the institute's criteria document on radiofrequency and microwave (RF/MW) radiation.

NIOSH's criteria document development division was slated to go to the institute's laboratories in Cincinnati, OH. Of the three experts on non-ionizing radiation in Rockville, MD, Dave West has left to join the National Center for Devices and Radiological Health and Drs. Momtaz Wassef and Paul Strudler are believed to be resisting the move to Ohio. Neither could be reached for comment. Wassef had been the principal writer of the document; now that responsibility has been transferred to the Physical Agents Effects Branch, which has always been in Cincinnati.

When the move was first proposed two summers ago (see *MWN*, July/August 1981), there were some 152 employees in Rockville; by last Christmas only 60 remained—most of these will stay in Washington, DC. For example, only one of 24 members of the criteria development division has decided to go to Cincinnati. Many NIOSH staffers have found new jobs at the center or other parts of the Food and Drug Administration and the Department of Health and Human Services.

Senior NIOSH officials in Cincinnati are reevaluating plans for the RF/MW criteria document. They are weighing the possibility of changing course and releasing a much shorter report which could serve as rationale for a future RF/MW occupational exposure standard. A trimmed down document could be completed by this summer, reliable sources said, whereas there was practically no chance a complete criteria document could be finished this year with the present staff. ●

## HIGHLIGHTS

### EPA Moves Forward on RF/MW Exposure Guidance

The Environmental Protection Agency (EPA) has formally announced its plan to propose a "guidance" for general population exposure to radiofrequency/microwave (RF/MW) radiation in September. EPA officials already have a working number for the limit, though they do not plan to reveal it for some time.

Observers are confident that the number will be somewhere between the 50  $\mu\text{W}/\text{cm}^2$  standard proposed in New York City and the new American National Standards Institute's 1,000  $\mu\text{W}/\text{cm}^2$  recommended guideline. Specifically, many are betting on 200  $\mu\text{W}/\text{cm}^2$ , which Massachusetts has proposed.

When final, the "guidance", unlike a standard, will only apply to federal agencies and their facilities. As the first national limit for public RF/MW exposure, however, its importance will far exceed its legal reach. Last year, the Federal Communications Commission (FCC) announced it will use EPA's number in determining whether proposed broadcast sources seeking licenses pose health hazards. (See *MWN*, March and September 1982.) The guideline will not cover occupational exposures or emissions from consumer products which, according to EPA, can be "more easily controlled" through performance standards.

The group at the Office of Radiation Programs (ORP) has finished a working draft of the guidance and plans to circulate it for inter-agency review this month. The office sent out letters in January requesting that interested federal agencies each appoint a staffer to participate in this preliminary evaluation.

The agency's Office of Research and Development (ORD) has prepared a draft criteria document on RF/MW bioeffects, which will serve as the basis for the guidance. The report is scheduled for public release in March when it goes to the Scientific Advisory Board (SAB) for review. The agency is now setting up a special panel to advise the SAB. Reliable sources say Professor Charles Susskind of the University of California, Berkeley, will be asked to chair the group. (By law, EPA must also consult the National Council on Radiation Protection and Measurement and the National Academy of Sciences on the guidance.) The publication of the criteria document is tentatively scheduled to coincide with release of the agency's notice of proposed recommendation in September.

Another support document, an economic impact study by the Environmental Sciences Division at the Department of Energy's Lawrence Livermore National Laboratory in Livermore, CA, should be completed by early summer.

The communications industry has been anxiously awaiting a national guideline on RF/MW radiation as proposed broadcast sources have met increasing opposition from community groups. Comments submitted last year on FCC's proposed RF/MW rules reflect industry fears over restrictive state and local standards.

EPA field measurements indicate most ambient radiation levels fall below even the strictest possible guideline. Based on readings from 15 cities, EPA estimates that over 99 percent of the population is exposed to RF/MW fields of less than 1  $\mu\text{W}/\text{cm}^2$ . The median residential exposure is 0.005  $\mu\text{W}/\text{cm}^2$  at FM radio and TV frequencies (up to 806 MHz) and 0.019  $\mu\text{W}/\text{cm}^2$  at AM radio frequencies. These bands are "the principal contributors to the general radiofrequency environment." Above 806 MHz, exposures are estimated to be "much less than 1  $\mu\text{W}/\text{cm}^2$  for most of the population." (The agency has asked for comments on what frequencies the guidance should cover.)

For people living near high power transmitters, exposures can be "considerably higher"—as high as 5,000  $\mu\text{W}/\text{cm}^2$  in localized areas—according to EPA. Measured levels near FM broadcast antennas reported in the notice go as high as 350  $\mu\text{W}/\text{cm}^2$  in a resi-

dential neighborhood and 97  $\mu\text{W}/\text{cm}^2$  in a tall office building. Exposures "in the range of 10 to 100  $\mu\text{W}/\text{cm}^2$  can occur at distances up to 0.5 miles from some radar systems and satellite communication earth terminals."

The agency lists five key areas it will consider in establishing limits, including: 1) mechanisms of interaction, 2) possible thresholds of effects, 3) reversibility of effects, 4) dependence of effects on duration of exposure and 5) whether biological effects adversely affect human health. It provides few clues, however, as to what types of exposure may be unsafe. The agency does cite Eastern European reports of behavioral and nervous system effects at levels below 1  $\text{mW}/\text{cm}^2$ , but then qualifies that this "limited clinical data suggest that these effects are reversible."

As for the key question regarding public safety, the agency only states, "It is not known whether the long-term, low-level exposures received by the general population can lead to irreversible adverse health effects, overt clinical disease, or whether adaptation can occur."

EPA is now awaiting comments on the scope and approach the guidance should take. The specific questions it wants addressed are listed below. Comments on the advanced notice (47 *FR* 57338, December 23, 1982) are due by February 22 but ORP's Norbert Hankin admits that he expects to receive some late replies. The agency will hold public hearings after the release of the proposed guidance.

### Questions Posed by EPA

We specifically request comment on the following:

1. What conceptual approach should be used to develop limits for exposure? Examples of some possible approaches for establishing exposure limits include:

- (a) Threshold for biological effects.
- (b) As low as reasonably achievable.
- (c) Limit risk to a level comparable with that for other environmental pollutants.
- (d) Use of best available or best achievable technology.

2. What range of frequencies should be included in the guidance?

3. Should different guidance be developed for partial-body and whole-body exposure?

4. Should the exposure limits take into account the fact that the rate of energy absorption varies with frequency?

5. Should limits be placed on maximum as well as average exposure?

6. Should limits be placed on instantaneous as well as time-averaged specific absorption rates?

We would appreciate comments on these questions and identification of other issues that should be considered in the development of this guidance. ●

### Canadian Group Recommends Limits for VLF Radiation from VDTs

A Canadian advisory group has recommended extending radiation standards to include the very low frequencies (VLF) emitted by some video display terminals (VDTs). In a statement issued in January, scientists at the Canadian Center for Occupational Health and Safety (CCOHS) say that although there is no known link between VDT exposure and reported reproductive problems, a cautious approach demands reducing emissions through shielding or terminal redesign until present uncertainty is resolved.

The center recommends that, on an interim basis, exposures to non-ionizing radiation from VDTs be limited to 60 V/m, as measured 30 cm from the set, for frequencies above 10 kHz. In Canada, a 60 V/m limit is already recommended by the province of Ontario for frequencies down to 300 kHz and by the federal government for frequencies down to 10 MHz. No standard in either the US or Canada now covers the 10-300 kHz band, though the

American Conference of Governmental Industrial Hygienists (ACGIH) has proposed limiting exposures to 614 V/m between 10 kHz and 3 MHz. The new American National Standards Institute (ANSI) standard does not recommend safety levels for frequencies below 300 kHz.

In considering possible causes for eight clusters of miscarriages and birth defects reported among VDT Operators (see *MWN*, July/August 1982), CCOHS scientists contend that "the weight of the scientific evidence is against ionizing radiation" because most VDT surveys show "negligible" X-ray emissions. Instead, they are looking to the pulse-modulated VLF fields produced by VDT flyback transformers.

Although the presence of VLF fields is widely acknowledged, most experts do not believe they are biologically active. CCOHS is focusing attention on the pulsed nature of these emissions because "pulse-modulated fields could be biologically more harmful than [unmodulated] fields." This is the first explanation, other than chance, for the clusters.

The center's Dr. Karel Marha cautions that research on the specific fields associated with VDTs must still be done. Nevertheless, he says the results of experiments with related pulsed fields provide a basis for concern. Czech researcher Dr. Hana Pafkova, for example, exposed pregnant mice for 17 days to a pulsed 300 Hz field with a peak value of 28,500 V/m and a pulse width of 10 microseconds and found "an unfavorable effect" on embryonic development. (Published in *Pracovní Lekarství*, (*Occupational Medicine*) 32, 334, 1980, written in Czech with an English abstract.)

In a telephone interview with *Microwave News*, Marha pointed out that the time-averaged field used by Pafkova was actually about 85.5 V/m, a level he called "not very high." He stressed that no one knows whether there is a radiation problem, but added, "if something is going on, these fields could be responsible."

The center's recommendation to limit these exposures drew sharp criticism from the Canadian Business Equipment Manufacturers Association in Toronto. In a telex sent January 10, the association's general manager Jim Flood warned the center that its statement would only create needless concern among VDT users and asked that it be withheld. According to Flood, "the center has proposed solutions to problems that don't exist: there is no evidence indicating VLF radiation is a hazard."

CCOHS scientists say only research, ranging from mathematical modeling to animal testing, will resolve the radiation issue and urge that this work be started. Noting that epidemiological studies are either underway or planned, they warn that there are too many confounding factors in this type of research to provide any clear-cut answers.

Marha has prepared a short paper, *The State of Knowledge Concerning Radiations From Video Display Terminals*, which reviews the types of emissions from VDTs. CCOHS is located at 250 Main Street East, Hamilton, Ontario, L8N 1H6, Canada. ☐

### NBS Designs New Meter to Measure E- and H-Fields Simultaneously in Near Field

Researchers at the National Bureau of Standards (NBS) have shown the theoretical feasibility of building a meter that can measure electric and magnetic fields *simultaneously* in the near field. Preliminary experiments, run at 100 MHz, indicate that the theory is correct. NBS' Dr. Moto Kanda said that a fully designed meter should be available within two years.

A sensor capable of measuring both electric and magnetic fields at a given point would represent a significant breakthrough— with widespread applications in the biological effects and radiofrequency interference communities. At present, there is no quick and reliable way of characterizing the components of low frequency (below 300

MHz) electromagnetic fields, which have extensive near fields.

Speaking from their laboratory at NBS' Electromagnetic Fields Division in Boulder, CO, Moto Kanda and Frank Ries said that, in the months ahead, they plan to design an isotropic antenna, to establish a flat frequency response for broadband measurements and to develop a fiber optic link so that the new sensor would not perturb the field.

Once the research and development is completed, NBS will disclose the meter's design to encourage the private sector to manufacture and market it. Kanda and Ries said that a number of companies have already expressed interest in the new meter.

Kanda is scheduled to describe the theoretical basis for the sensor in a paper to be presented at the *Electromagnetic Compatibility Symposium* to be held in Zurich, Switzerland, in early March. ☐

### Wertheimer Extends Cancer Study to Adults

Dr. Nancy Wertheimer and Ed Leeper have extended their 1979 work on childhood cancer and 60 Hz fields to adults: they have identified a "highly significant" association between the incidence of adult cancer and alternating magnetic fields (AMFs), though it was "considerably weaker" than the association observed for children. They contend that prolonged exposure to AMFs may promote the development of cancer.

While admitting that epidemiologically derived results can always turn out to be artifactual, the Colorado researchers argue that the association between cancer and the presence of high current electrical distribution lines may be a causal link because: "(1) a dose-relationship was observed; (2) two different control procedures yielded essentially similar results; (3) the strength of the associations observed in different age, urbanicity and socioeconomic groups was consistent with a causal interpretation; (4) a distinct pattern of latency between first exposure to the [high current configurations] and cancer diagnosis was seen, which is consistent with a hypothesis of cancer promotion produced by [exposure to AMFs]."

Wertheimer and Leeper maintain that the stronger association with children relative to adults may not indicate that children are more susceptible to the effects of AMFs—rather that any increase in cancer rates would show up more clearly in a population with a low incidence of cancer such as children.

In recent months, there have been three other reports connecting extremely low frequency (ELF) radiation to cancer. Studies from Washington state and California have found indications that workers exposed to electromagnetic fields have a greater risk of developing leukemia (see *MWN*, July/August and December 1982). And a Swedish team found support for Wertheimer and Leeper's 1979 results among Stockholm residents exposed to 50 Hz fields (see *MWN*, November 1982).

"Adult Cancer Related to Electrical Wires Near the Home" appears in the *International Journal of Epidemiology*, 11, 345, 1982. Wertheimer is with the Department of Preventative Medicine and Community Health at the University of Colorado Medical Center in Denver. ☐

### ITT Settles Engell Suit

Attorneys for ITT and Robert Engell agreed to an out of court settlement on December 23. Engell had filed a \$4.5 million claim alleging that he had developed pancreatic cancer due to radiation exposure from tactical air navigation (TACAN) equipment manufactured by ITT. None of the attorneys involved would divulge the amount of the settlement, though one source did remark that more than nuisance money is involved.

Marc Moller and Michael Young, two of Engell's attorneys at the New York City law firm of Kreindler & Kreindler, said that they

were pleased with the outcome in the light of the present state of knowledge on radiation injuries. They said that Engell is satisfied. Matthew Shafner of O'Brien, Shafner, Garvey, Bartnik & Stuart of Groton, CT, was co-counsel on the case.

ITT was represented by John FitzGerald of the Hartford, CT, firm of Howard, Kohn, Sprague & FitzGerald; he refused to discuss the settlement.

A jury had been selected and the trial was scheduled to begin on January 5 in US District Court in Hartford. Engell's original suit, filed in 1977, named General Dynamics, Raytheon, Rockwell International and Varian Associates as co-defendants along with ITT. All four companies settled out of court in November; those agreements also stipulated that the settlements be kept confidential.

Engell worked at the Naval Air Rework Station on Quonset Point, RI, from 1965 until it was closed in 1973. He and one of his co-workers, Donald Cadieux both developed pancreatic cancer. More specifically, Engell had nonbeta islet cell cancer of the pancreas while Cadieux had adenocarcinoma of the pancreas. Cadieux died

in October 1974; his widow's claim of wrongful death was barred under the Rhode Island statute of limitations.

One medical opinion, solicited by Engell's attorneys and placed in the court's records, states that "to find two men under 40 to have contracted pancreatic cancers in the same place is so highly unusual as to invite the inference that the disease states in each of them was occupation related." The expert was Dr. Leonard Dauber, an assistant clinical professor of medicine at Albert Einstein College of Medicine in New York City.

ITT never acknowledged that TACAN radiation caused the cancer; but, according to Young, the company filed papers with the court admitting there were no warnings of potential radiation dangers on the equipment when Engell worked on it. Among those listed as experts for ITT were: Drs. Don Justesen, Sol Michaelson, John Osepchuk, and Paul Tyler.

TACAN operates at frequencies of 1.025-1.213 GHz. In addition, the men were probably exposed to X-ray radiation from the rectifier tubes in the high voltage power supply. ●

## UPDATES

**Biological Effects . . .** Dr. Carl Blackman and his colleagues at EPA published their latest findings on ELF-induced calcium efflux from brain tissue in the December *Radiation Research*. As Blackman reported at last summer's BEMS conference (see *MWN*, July/August 1982), the EPA group used 16 Hz sinusoidal fields *without* a carrier wave and found two power windows of enhanced efflux at 5-7.5 V/m and 35-50 V/m. These results are similar to those obtained with 50 and 147 MHz carrier waves modulated at 16 Hz, leading them to the conclusion that the RF carrier is not the responsible agent. They write that the experiment provides: "strong evidence against any potential mechanism of action that invokes generalized heating as the underlying cause." Blackman's findings disagree with those of a similar experiment run some years ago by Drs. Suzanne Bawin and Ross Adey. While both groups identified the same frequency specificity, Bawin and Adey found a reduction in calcium efflux while the EPA researchers found an enhancement—a difference that remains unexplained. At the 1982 BEMS meeting, Blackman said that he planned to see if higher ELF frequencies affected calcium mobility. In a telephone interview, Blackman said that he is in the process of running experiments at frequencies of up to 120 Hz. He predicted that he would have some results for the 1983 BEMS meeting, which will be held in Boulder, CO, in mid-June. . . . Professor Bill Guy will also be in Boulder to present the near-final results of his multi-million dollar, long-term study. Guy's research team at the University of Washington, Seattle, turned off the power last September after exposing 98 rats to 2450 MHz, 8 Hz pulsed microwaves for 36 months. The statisticians are still at work, Guy told *Microwave News*, but the preliminary indications are that there were no significant differences between the exposed and control animals. At last year's BEMS meeting, there was a paper out of Guy's lab indicating there might be some changes in T and B cells among the rats exposed to microwaves, but these were not confirmed by later tests. Guy said that he would like to do some more work on the effects of radiation on the immune system as well as the metabolic changes that follow irradiation. Now that the experiment is over, Guy intends to design improved applicators for hyperthermia treatment. . . . Another, though less ambitious, chronic study is reported by two Canadian researchers in the second issue of *Journal of Bioelectricity*, published by Marcel Dekker. Dr. J. A. Tanner of the National Research Council of Canada in Ottawa and Dr. C. Romero-Sierra of Queen's University in Kingston, exposed a colony of leghorn chickens to 7.06 GHz CW from a four-foot parabolic dish for more than 200 days: field intensities ranged from 0.19 uW/cm<sup>2</sup> to 360 uW/cm<sup>2</sup> depending on the location of the cage with respect to the dish. Microwaves increased egg production by 13 percent over the controls but was accompanied by double the mortality rate—mostly from avian leukosis and tumors in the central nervous system. In addition, the birds that survived showed a pronounced deterioration in health. The authors explain these adverse effects at such low levels with the hypothesis that "high intensity fields trigger thermal effects that block the non-thermal effects identified with low intensity fields." . . . Meanwhile scientists at the Battelle Northwest Laboratories have been investigating the

effects of magnetic fields on trout. Battelle's Dr. John Strand reports that "fertilization was enhanced when ova and sperm of rainbow trout were exposed to a 1-tesla magnetic field before fertilization." A number of other magnetic field studies are also underway at the lab; to date, no adverse impacts have been detected. . . . As anticipated, ONR has picked up the abstracting of the bioeffects literature from NTIA. The BENER (Biological Effects of Non-Ionizing Electromagnetic Radiation) digests will continue to be prepared by Bruce Kleinstein under a newly created company, Information Ventures. Kleinstein, who is based in Philadelphia, PA, has received a one-year \$72,000 contract, renewable for two more years, to prepare a quarterly review of the world's bioeffects research. The digest will pick up where NTLA left off; the first issue will begin with January 1982. If renewed, the total contract will be worth \$212,000. . . . The research group at the University of Utah continues to turn out a large number of papers. Two recent additions were published in the November *IEEE Transactions on Microwave Theory and Techniques*: Professor Om Gandhi presents a review of the bioeffects and medical applications of RF/MW fields and, with two of his colleagues, some results on radiation absorption in the near field. . . . The most recent contribution to the debate on the potential hazards of fluorescent lights appeared in the November 27 *Lancet*. Dr. Robert Stern of Harvard Medical School contends that the increased risk of melanoma associated with fluorescent light in a recent study (see *MWN*, September and December 1982) is likely to reflect a bias in the selection of controls rather than a true risk. . . . Professor Albert Krueger died in December at the age of 80. Krueger, who spent much of his career at the University of California, Berkeley, was a leading researcher on the biological effects of air ions.

**Communications . . .** MCI Communications Corp. is bullish on fiber optics. Since November the company has purchased rights-of-way for over 4,000 miles of cables, including the Washington, DC, to New York City corridor. MCI chairman William McGowan says the east coast link will boost transmission capacity at a cost that is "far more economical" than expanding the company's existing point-to-point microwave network. The new technology, which is digital, can also improve transmission quality because it is immune to interference. . . . Meanwhile, ITT continues its efforts to site a point-to-point tower in northern New Jersey, one link in a planned network between Newark and Boston. A permit application was rejected by South Nyack, NY, last year and the company is now seeking approval in Ringwood, NJ, for the tower. In a January 21 release addressing community concern over potential radiation hazards, the company said the calculated power density at the base of the tower would be 0.02 uW/cm<sup>2</sup>. . . . The organizers of the community group opposing RCA's application for an additional point-to-point station at its satcom facility in Vernon, NJ, (see *MWN*, November 1982) showed up at Ringwood's January public meeting on the ITT tower. RCA came too. . . . The November 1982 issue of the *Proceedings of the IEEE* is devoted to UHF-TV. . . . Telex Communications' Hy-Gain divi-

sion has issued a catalog of commercial, industrial and military HF, VHF and UHF antennas. For a copy, write to Hy-Gain, CIM Department, 8601 NE Highway Six, Lincoln, NE 68505. . . . Next year, your car radio might belt out the top 40 in stereo. Delco Electronics, a division of General Motors and the largest US maker of car radios, has decided to use Motorola's system for AM stereo radio. This is a major break in the standoff among three non-compatible systems hoping to win market acceptance. Harris Corp. and Magnavox are the losers in this round.

**Compatibility & Interference.** . . The FCC has closed its books on a notice of inquiry, adopted in December 1975, to investigate possible interference from spark-type ignitions to communication systems. In a memorandum, opinion and order released January 4, the commission states that there is little justification for pursuing the matter because the incidence of RFI from spark-type ignitions is decreasing and will probably continue to do so. . . . Video games, on the other hand, are another story. In mid-December, the AP featured a story about RFI complaints at a fire company in Milford, DE. Two video games had to be removed from the firehouse because they were interfering with land mobile units in the firetruck and confounding the transmission of alerts to the firemen's homes. The video game RFI problem may get worse after Christmas, according to an FCC staffer quoted by the AP, when all those games come out from under the trees. . . . The Army Aviation R&D Command and NBS are planning a five-year effort to improve the army's EMC measurement program for helicopters, light aircraft and remote-piloted vehicles. The EMC program will include an assessment of shielding materials and military standards 461 and 462, as well as a study of the feasibility of establishing a government high-field-strength EMC test facility and a study of improved methods for electromagnetic pulse testing. . . . The FAA has signed a contract with the Department of Electrical Engineering at Ohio University in Athens to measure radiated emission from ISM equipment at an open field test site and at the actual location where the ISM equipment is operated. The FAA wants field strength measurements in the air over the ISM devices at a minimum of three different altitudes above the test site. . . . The Energy and Environment Division of the Lawrence Berkeley Laboratory at the University of California has issued the *Proceedings of the Lighting-Electromagnetic Compatibility Conference*, held at the lab last March 18-19. A limited number of copies of the report (No. LBL-15199) are available from Dr. Rudy Verderber, Lighting Systems Research Group, LBL, Berkeley, CA 94720. Afterwards, it will be available from the National Technical Information Service, Springfield, VA 22161.

**EMP.** . . Concern over the possible impact of electromagnetic pulse (EMP) radiation on communications and energy systems continues to grow. While DOD has budgeted a major effort to protect vital military communication links from EMP disruptions, Edward Teller is worried about the EMP threat to industry. Writing in the October issue of the *IEEE Spectrum*, Teller speculates that in the event of heavy EMP radiation "it would be easier to enumerate the apparatus that would continue to function than the apparatus that would stop." Teller calls for the declassification of essential DOD documents because, unless precautions are taken, "the civilian economy faces the prospects of grinding to a halt in a nuclear encounter." With respect to the effects of EMP on electric power systems, a number of studies are already underway: the Zaininger Engineering Co. is characterizing EMP coupling and interactions for the Oak Ridge National Laboratory (Zaininger has subcontracted research on EMP effects on three phase circuits to the Dikewood Corp. and on magnetohydrodynamic-EMP surges on long transmission lines to the Mission Research Corp.) The Boeing Co. is looking at the effects of EMP on power system components for the Defense Nuclear Agency (DNA); DNA is also sponsoring the development of an advanced arrestor for EMP from surface nuclear bursts at General Electric. The Nuclear Regulatory Commission has contracted with Sandia National Laboratory for a major study of the effects of EMP on nuclear power plant safety systems; other related studies are planned. (Preliminary results from Sandia indicate that safety systems should not be damaged.) Most recently, Union Carbide, which runs Oak Ridge for DOE, has issued a RfP (No. 19-4456) for an assessment of the effects of EMP on utility electric power systems and for recommendations on how they can be protected. . . . Much of the public awareness of EMP is attributable to articles by William Broad in *Science* and Janet Raloff in *Science News*. Broad has now written a popular piece, "The Chaos Factor," which is the cover story in the January/February issue of *Science* 83. Broad recently left *Science* to join the *New York Times*. . . . A comparison

of electromagnetic fields (in the frequency range  $10^4$ - $10^7$  Hz) from nuclear EMP with those from lightning appears in the November issue of the *IEEE Transactions on Electromagnetic Compatibility*.

**Government.** . . Bruce E. Fein has been appointed general counsel at the FCC. Fein comes to the commission from the Department of Justice. . . . FDA has renewed the charter of its Technical Electronic Product Radiation Safety Standards Committee (TEPRSSC) for two more years. The date of the committee's next meeting has not been announced.

**International.** . . The Industrial Injuries Advisory Council in London, UK, is reviewing occupational risks associated with exposure to electromagnetic fields, including ionizing and non-ionizing radiation. For more information contact the council at Friars House, 157-168 Blackfriars Road, London SE1 8EU. . . . Visiting Chinese scientist Zhi-Yuan Shen reports that the *Third National Symposium on Microwave Power Applications* will be held in China later this year; the exact date and place of the conference have yet to be decided. With respect to medical applications, he said that needles are being used as antennas to transmit microwaves in acupuncture treatments in Chinese hospitals. The needles transmit 1 GHz radiation. . . . Howard Bassen and John Monahan of the National Center for Devices and Radiological Health left for the Soviet Union in mid-January as part of the joint US-USSR research program on non-ionizing radiation (see *MWN*, July/August 1982). Bassen will be checking dosimetry at Dr. Mikhail Shandala's lab in Kiev, while Monahan will review the experiment's behavioral protocols. Afterwards, Monahan will visit other labs in Moscow and Leningrad.

**Measurement.** . . NBS has issued three new publications: (1) a new edition of its catalog, *Calibration and Related Measurement Services of the National Bureau of Standards* (SP 250-1982), which includes a special appendix listing contacts and prices for each service. It is available for \$6.00 prepaid from the Superintendent of Documents, US Government Printing Office, Washington, DC 20402. Stock No. 003-003-02446-5. The appendix is updated every six months free of charge; (2) *Metrology for Electromagnetic Technology: A Bibliography of NBS Publications* (NBSIR 82-1677). This volume, which covers papers and reports published by the bureau's Electromagnetic Technology Division staff between 1970 and 1981 on microwave circuits and pulsed electromagnetic phenomena among many other subjects, can be purchased for \$9.00, prepaid, from the National Technical Information Service (NTIS), Springfield, VA 22161. Order No. PB 83-111658; (3) *Bibliography of the NBS Electromagnetic Fields Division Publications* (NBSIR 82-1673) lists the division's 1980-81 reports on measurement methods and standards as well as antenna systems and RFI. Available from NTIS for \$6.00. Order No. PB 83-119776. . . . A session at the *1983 Measurement Science Conference* held in Palo Alto, CA, January 20-21, featured three papers on automated testing techniques for microwave technology. Algje Lance of TRW Systems in Redondo Beach, CA, organized the session and presented one of the papers; the other two were by Mike Cuevas and John FitzPatrick, who both work at Hewlett-Packard. For more information, contact Lance at (215) 535-5167.

**Medical Applications.** . . A hyperthermia unit manufactured by BSD Medical Corp. of Salt Lake City, UT, failed to receive premarket approval (PMA) from the FDA at a December 8-9 Radiologic Devices Panel meeting in Rockville, MD. An evaluation by officials at FDA's National Center for Devices and Radiological Health recommended approval for the cancer treatment unit with respect to safety and engineering, but there were some doubts about the machine's efficacy due to insufficient statistical controls in the submitted clinical data. BSD presented results from treatments with radiation and hyperthermia but not with radiation alone. Dr. J. William Dirksen, director of research and regulatory affairs at BSD told *Microwave News* that the company was in the process of generating the necessary data and that the company would resubmit the PMA application in early February. In 1981, Henry Medical Electronics' Magnetron unit also failed to clear PMA (see *MWN*, May 1981). To date no hyperthermia device can be marketed to treat cancer. . . . At the same meeting, there was discussion, initiated by the National Electrical Manufacturers Association (NEMA), on the possibility of changing the classification of NMR imagers from Class III to Class I or II, which do not require PMA. The panel expressed its interest in reclassification, but advised that it was up to NEMA to take formal action by filing a petition. In an interview, NEMA's Robert McCune said the group

was in the process of polling its member companies on the merits of such an action. . . . The National Cancer Institute (NCI) has set up a new committee, the Cancer Therapeutics Program Project Review Committee to advise NCI staff on "the merit review of applications requesting support for clinical and laboratory program project proposals." . . . In the latest issue of the *Journal of Bioelectricity* (Volume 1, Number 2, 1982), Drs. Stephen Smith and Jose Feola of the University of Kentucky College of Medicine report on experiments designed to see whether the pulsed magnetic fields used to heal nonunion fractures affected the course of malignant tumor development. They used a pulse generator made by *Electro-Biology* (which also supported the research) that emits a 5 millisecond train of 29 pulses, repeating at 15 Hz, inducing a peak magnetic field of about 20 gauss—an average field of 2–3 gauss. They found the magnetic field had: (1) little effect on survival, though there was a slight trend towards reduced survival; (2) a "quite remarkable" effect on internal organs; and (3) a general trend "towards the inhibition of the tumor and suppression of metastasis." As the authors themselves note, the results present "an interesting picture, not altogether easy to interpret." . . . In the same issue of the *Journal of Bioelectricity* Dr. Robert Becker, who recently retired from the Upstate Medical Center in Syracuse, NY, presents a review of "Electrical Control Systems and Regenerative Growth." . . . A group from Aberdeen, Scotland has used NMR to examine six patients in the first trimester of pregnancy, prior to termination. They report in the January 1/8 *Lancet* that the "fetal detail displayed by NMR is greater than that seen by ultrasound" and that there appear to be "no short or medium term side-effects." They caution, however, that "there is insufficient information from animal work about [NMR imaging's] mutagenicity to advocate the use of NMR in human pregnancy at this time." . . . Other recent NMR articles include a description of NMR imaging at Hammersmith Hospital in London in the November issue of *Radiography*, and "NMR Spectroscopy of Living Cells" by R.G. Shulman of Yale University in the January *Scientific American*. . . . IBM Instruments has agreed to help advance NMR imaging with grants of \$1.9 million to Harvard Medical School's Brigham and Women's Hospital and \$1.5 million to MIT's National Magnet Lab. . . . *Clini-Therm Corp. of Dallas, TX, will do R&D on cancer treatment for Hyperthermia Associates of Nashville, TN, under a \$440,000 contract.* . . . Dr. Margaret Patterson has developed a "black box" that sends weak electrical signals into the brain to help addicts kick the habit. Her NeuroElectric Therapy works for drugs, alcohol and cigarettes. In a detailed article in the January *Omni*, Kathleen McAuliffe describes the box and Patterson's remarkable success rate. Interestingly, Patterson found that different frequencies helped different addictions: 75–300 Hz for narcotics and sedatives, lower frequencies for barbiturates and approximately 2,000 Hz for cocaine and amphetamines. Patterson claims that her treatment does not cause any compensating "electronic addiction."

**Ovens** . . . A total of 4.07 million microwave ovens were shipped in 1982, down 7.9 percent from 1981, the record year for the industry. Despite the decline, sales have nearly doubled during the last five years. The Association of Home Appliance Manufacturers (AHAM), which compiles these statistics, believes that the future will be rosy: it points out that only one in four homes now has a microwave oven. . . . DOE has decided that energy efficiency standards for ovens, ranges and clothes dryers are not worth setting. In a final rule published in the December 22 *Federal Register* (47 FR 57198), the agency finds that such standards "would not result in a significant conservation of energy and would not be economically justified." When DOE first proposed a "no standard" approach, some congressmen voiced their displeasure (see *MWN*, June 1982). This time, Congress was in recess for the Christmas holidays and the rule passed relatively unnoticed. . . . Rubbermaid has introduced a line of microwave cookware made of a new material it calls "Micrel." The company claims the products are "virtually unbreakable and won't warp, even with drastic temperature changes from freezer to microwave oven to dishwasher, where it is bottom rack safe." . . . Magic Chef plans to introduce a new line of microwave ovens at the end of January.

**Power Lines** . . . The Minnesota Environmental Quality Board (MEQB) has concluded that the state's construction permit for the Cooperative Power Association-United Power Association 800 kV DC power line is adequate to protect public health and safety without modification. In its December 21 ruling, the board did order continued monitoring of the electrical environment around the line, however, and asked the Minnesota Department of

Health to investigate the potential interference hazards of a line converter station to pacemakers. The board decision on the line running from a North Dakota coal field to Minneapolis/St. Paul, MN, follows the recommendations of its scientific advisory panel. The panel states in its report that "no additional standards are needed for safe operation of the line," though it also says that resolution of power line health effects issues "will definitely require well defined and replicated epidemiological studies," which in turn require more research on air ion concentrations. The advisors conclude that "the likelihood of long-term biological effects from the air ions generated by the line is considered to be low. However, we have virtually no direct information from any long-term studies of air ion effects." (See *MWN*, October and December 1982.) MEQB also reviewed a dairy cattle study by researchers at the University of Minnesota and reports on the state's program monitoring the electrical environment around the lines. For information on the availability of the reports, contact George Durfee, Manager, Power Plant Siting Program, MEQB, 15 Capitol Square Building, 550 Cedar Street, St. Paul, MN 55101.

**Satellite Communications** . . . The draft environmental impact statement (EIS) for Teleport, a satellite communications complex planned for Staten Island, NY, was released by the New York City Development Corp. and the Port Authority (PA) of NY and NJ on January 3. The facility would include 17 satellite antennas and eventually employ over 7,000 people. According to the draft, radiation levels near Teleport are not expected to exceed 3 uW/cm<sup>2</sup>—well below the 50 uW/cm<sup>2</sup> limit proposed as a population standard for New York City. Summary information in the EIS indicates safeguards in the project's design and operation would include continuous radiation monitoring and an alarm system, with an automatic cut-off, activated if radiation levels exceed 50 uW/cm<sup>2</sup>. The facility would be surrounded by some form of wall to shield its antennas from external interference and to reduce RF/MW levels outside the site. Dr. Paul Tyler of the Defense Nuclear Agency reviewed the bioeffects literature for the statement, which concludes that "no hazardous conditions have been identified at the power density levels (maximum 3 uW/cm<sup>2</sup>) and radio frequencies (4 to 14 GHz) proposed for use" at Teleport. (Details are presented in a technical support document, *The Teleport Electromagnetic Energy Study*, 1982, by Ammann & Whitney, which was not yet available in late January.) Both Teleport, sponsored by the PA and Merrill Lynch, and an all-office development plan are considered in the EIS. A hearing on the project before the NYC Department of Environmental Protection and the NYC Planning Commission is scheduled for February 2. (See *MWN*, June 1982.) . . . RCA Americom's request to build a satcom station in the Indianola-Kingston area, near Seattle, WA, was denied by the Kitsap County Board of Commissioners for the second time on January 24. Company plans to site the facility on the county's Bainbridge Island and later in a forest near Kingston have met strong community opposition. Commenting on the ruling, Americom spokesman John Williamson said the company "will not pursue the Kitsap proposal at the present time," though "we still plan to start serving the Seattle area in 1983, from one location or another." The board refused RCA's application last year but was asked to consider it again after the company filed suit in state court (see *MWN*, December 1982) . . . A state superior court judge for nearby King County, WA, denied a citizen's group petition to block completion of Alascom's satcom station on Vashon Island. Members of Vashon for Quality Environment are likely to appeal the January decision to a higher court (see *MWN*, December 1982) . . . The UN General Assembly has approved a resolution barring direct satellite transmissions across national borders without the receiving country's consent. The December 10 vote followed the endorsement of the measure by a UN special political committee in November. . . . *The Satellite Communications Market in Western Europe*, a 383-page report from Frost & Sullivan, includes estimates for various sectors of this market totalling over \$8.5 billion by 1992. Report No. E564 costs \$1,600 and is available from the company at 106 Fulton Street, New York, NY 10038, (212) 233-1080.

MICROWAVE NEWS is published monthly, except in January and July • ISSN 0275-6595 • PO Box 1799, Grand Central Station • New York, NY 10163 • (212) 794-9633 • Editor: Louis Slesin, Ph.D., Associate Editor: Martha Zybko • Subscription: \$200 per year (overseas \$235) • Copyright © 1983 by Louis Slesin • Reproduction in any form is forbidden without written permission.

## SHORT COURSES

VDTs... The Labor Education and Studies Center of the Canadian Labor Congress (CLC) has recommended in-depth studies to determine whether VDTs pose radiation risks. Citing concern over PCB's as well as very low frequency radiation, the center also urges that "long-term studies into reproductive hazards be undertaken immediately." The recommendations are included in its 241-page report on VDTs, which covers mainly non-radiation issues. A center survey of 2,330 Canadian workers found no evidence linking cataracts or reproductive problems to VDTs, but it cautions that only a study following a large group of workers over a long period could give conclusive results. The full report, *Towards a More Humanized Technology*, is available for \$20, and a 46-page digest for \$5, from the Center at 2841 Riverside Drive, Suite 301, Ottawa, Ontario, K1V 8N4, (613) 731-3052... The Labor Council of Metropolitan Toronto reviews the CLC report in a special issue of its *VDT Newsletter* to be released this month. The council is also planning a conference on stress associated with VDT work on April 30. For information, contact the Council's VDT Committee, Room 407, 15 Gervais Drive, Don Mills, Ontario... Several state legislatures may consider action on VDTs this year. In New York, a draft VDT safety bill sponsored by Brooklyn Assemblyman Frank Barbaro should be finished this month. And bills for establishing committees to investigate VDTs and possibly recommend legislation have been prepared by Connecticut's Committee on Labor and Public Employees (Study Bill 5132) and by Massachusetts' Committee on Commerce and Labor. VDT legislation proposed last year in Massachusetts (House Bill 2910) never reached the floor. (See *MWN*, April, 1982.)... NIOSH will investigate the relationship between stress and VDT work during an eight month study headed by Dr. Lawrence Scheifer at its laboratories in Cincinnati, OH. About 30 typists will participate. The project is not connected with two ergonomics studies now starting up under NIOSH's Dr. Michael Smith. (See *MWN*, December 1982.)... The North Carolina Occupational Safety and Health Project has asked interested union locals in the state to participate in a VDT worker survey on stress, ergonomics and potential reproductive problems. Contact Tobi Lippin, NCOSH, Box 2514, Durham, NC 27705... Reports on new office technology appearing in the International Labor Organization's (ILO) *Social and Labor Bulletin* have been compiled and republished. The ILO book covers reports appearing since 1979 from a number of countries on such topics as general policy issues, labor relations and collective agreements, trade union viewpoints and the working environment. The 174-page *New Technologies: Their Impact on Employment and the Working Environment*, 1982, is available for \$11.40 from ILO, Washington Branch, 1750 New York Avenue, NW, Washington, DC 20006... Two Canadian researchers have concluded that "there are clearly no significant technological or economic problems in achieving emission levels far below the current regulatory limit" for X-ray emissions from VDTs. In the November 1982 *Health Physics*, C.A. Hirning and J.H. Aitkin of the Ministry of Labor in Toronto report: "As long as VDTs are being made with X-ray emissions as low as the vast majority of those currently available, there is no significant radiation risk to the users and no need for any additional regulatory action. If, however, a trend toward higher emission levels were observed... then the [as low as reasonably achievable] principle should be invoked to require manufacturers to reduce emissions again to the present negligible levels"... The Electronic Industries Association is working on a new standard, *Recommended Practice for Measurement of X-Radiation from Direct-View Television Picture Tubes*, TEPAC Publication No. 164. For information, contact the EIA, 2001 I Street, NW, Washington, DC 20006, (202) 457-4900... A summary of the October 1982 *International Conference on Office Work and New Technology*, sponsored by Working Women should be available in March. For information, contact the organization at 1224 Huron Road, Cleveland, OH 44115... Word processors have been the source of a different kind of office problem at Ford Motor Company in Dearborn, MI: a gambling operation handling over \$5,000 a week. The January 10 *Computerworld* reports that state police nabbed three clerks who allegedly used their terminals to run a football betting pool. ●

*Microwave News* has published *VDTs: Health and Safety*, an 80-page booklet with an index containing all of our 1981-2 coverage of video display terminal issues. Copies are available prepaid for \$5.95 plus \$1.00 for postage and handling from: *Microwave News*, PO Box 1799, Grand Central Station, New York, NY 10163. For bulk rates (over 10 copies), please call us at (212) 794-9633. (US funds please. If your check is not drawn on a US bank, please add \$3.00 per order.)

- March 2-4: *Mobile Communications Engineering*, Washington, DC. Fee: \$685. Contact: George Washington University, Continuing Engineering Education, Washington, DC 20052, (800) 424-9773.
- March 7-8: *EMI/Testing Praxis*, suburban Philadelphia, PA. Fee: \$495. Contact: R&B Enterprises, 1050 Colwell Lane, Conshohocken, PA 19428, (215) 828-6236. Repeated • May 16-17.
- March 7-11: *Microwave Circuits: Theory and Applications*, Vienna, VA. Fee: \$850. Contact: Continuing Education Institute, 10889 Wilshire Blvd, Suite 1000, Los Angeles, CA 90024, (213) 824-9545. Repeated • April 4-8 in Palo Alto, CA.
- March 7-11: *MIL-STD 461/462 & System-Level EMI Testing and Procedures*, Washington, DC. Fee: \$965. Contact: Don White Consultants, PO Box D, Gainesville, VA 22065, (703) 347-0030.
- March 14-17: *Computational Methods in Electromagnetics*, Champaign, IL. Fee: \$580. Contact: Southeastern Center for Electrical Engineering Education, 11th & Massachusetts Avenue, St. Cloud, FL 32769, (305) 892-6146.
- March 14-18: *Spread-Spectrum Techniques and Vulnerability*, New York, NY. Fee: \$565 (IEEE), \$715 (non-IEEE). Contact: IEEE Continuing Education, Attn: Rosanne Santangelo, 445 Hoes Lane, Piscataway, NJ 08854, (201) 981-0600 x 328.
- March 21-23: *MM Wave Technology*, Washington, DC. Fee: \$650. Contact: Palisades Institute for Research Services, 201 Varick St., New York, NY 10014, (212) 620-3377. Repeated • April 5-7 in San Francisco, CA.
- March 22-25: *Grounding and Shielding*, Orlando, FL. Fee: \$760. Contact: Don White Consultants, see March 7 above.
- March 24-25: *Hazardous Electromagnetic Radiation and Its Biological Effects*, Washington, DC. Fee: \$625. Contact: George Washington University, see March 2 above.
- March 28-April 1: *EMI Design and Testing*, Orlando, FL. Three one-day sessions on *Requirements & Testing per FCC Docket 20780*, *Designing to Meet FCC Docket 20780* and *Printed Circuit Board and Wiring Design for EMI Control*. And one two-day session on *Grounding, Bonding and Shielding*. Fee: \$260 for one-day sessions and \$495 for two-day sessions. Contact: R&B Enterprises, see March 7 above. Repeated: • April 11-15 in San Francisco, CA; • April 18-22 in Los Angeles, CA; • May 2-6 in Chicago, IL; and • May 9-13 in Boston, MA.
- March 29-31: *Interference Control: An Introduction to EMI/RFI/EMC*, Washington, DC. Fee: \$760. Contact: Don White Consultants, see March 7 above.
- April 5-8: *Millimeter-Wave Radar*, Washington, DC. Fee: \$780. Contact: George Washington University, see March 2 above.
- April 12-14: *Advanced Radar Technology*, Washington, DC. Fee: \$685. Contact: George Washington University, see March 2 above.
- April 18-22: *Spectrum Management*, Washington, DC. Fee: \$855. Contact: George Washington University, see March 2 above.
- April 25-29: *Communications Satellite Engineering*, Fee: \$855. Contact: George Washington University, see March 2 above.
- May 2 & 4: *EMI Test and Evaluation*, San Jose, CA. Fee: NA. Contact: Don White Consultants, see March 7 above. This course will be given at the *Test & Measurement Expo*. A number of other courses and workshops are also scheduled. For more information, contact Meg Bowen, (617) 254-1445.
- May 16-20: *Basic Radiological Health Course*, San Antonio, TX. Fee: \$450. Contact: University of Texas Health Science Center, Medical School Continuing Education Services, 7703 Floyd Curl Drive, San Antonio, TX 78284, (512) 691-6295.
- May 23-27: *Radar Systems and Technology*, Washington, DC. Fee: \$855. Contact: George Washington University, see March 2 above.
- June 6-10: *Advanced Radiological Health Course*, San Antonio, TX. Fee: \$550. Contact: University of Texas Health Science Center, see May 16 above.
- June 13-17: *Radiation Safety Officer's Course*, San Antonio, TX. Fee: \$600. Contact: University of Texas Health Science Center, see May 16 above.