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Human Tumor Cells Thrive in ELF Magnetic Fields

Human tumor cells proliferate more easily and are more immune to attack when exposed to power line fields, according to Dr. Jerry Phillips of the Cancer Therapy and Research Foundation in San Antonio, TX.

Because the field effects persist for months after exposure to extremely low frequency (ELF) radiation, Phillips argues that 60 Hz fields "are capable of producing significant permanent changes in cellular structure and function."

Phillips's results, presented in a series of recent papers, may be the first step in explaining the abnormally high cancer rates identified among people exposed to electromagnetic fields (EMFs). "Our studies are very much in concert with the epidemiological studies that have been published," Phillips told *Microwave News* in a telephone interview.

A recent review of epidemiological surveys by Dr. Tom Tenforde of the Lawrence Berkeley Lab in California indicates that 15 of 17 reports showed "some apparent correlation between cancer and EMFs" (see *MWN*, March/April 1986). New findings continue to support an association between ELF and cancer (see *MWN*, May/June 1986).

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Workers Claim Radar Accident at Maine Shipyard

As many as 23 workers may have been exposed to high levels of radar radiation at the Bath Iron Works (BIW) shipyard in Portland, Maine, on March 19. BIW officials contest the men's claim that a U.S. Navy ship's radar was accidentally turned on while they worked nearby.

Most of the men reported facial burns, red arms and suntans following the alleged incident, even though it rained that day. Among the other most common complaints were severe headaches, irritated eyes, nausea and exhaustion. At least one worker says he is still suffering severe ill effects and has not returned to work.

The radiation came from an AN/SPS-49 long-range air-search radar aboard the U.S.S. Taylor, a guided-missile frigate, according to officials of Local 6 of the Industrial Union of Marine and Shipbuilders of America, which represents the workers. The radar was built by the Raytheon Co. of Wayland, MA.

A BIW spokesman told *Microwave News* that the radar was "sector-blanked" — that is, it could not have exposed the men in the shipyard. But Jim Mackie, the chief steward of Local 6, disagreed: "All somebody had to do was hit one button and the sector-blanking would have been turned off," he said in an interview.

Mackie pointed out that, at the time the radar is believed to have been on, walkie-talkies stopped working in the yard and fire alarms went off in the drydock for no apparent reason.

(continued on p.14)

EPA's Four Options for Public Exposures to RF/MW Radiation

The Environmental Protection Agency (EPA) has proposed options for protecting the public from radiofrequency and microwave (RF/MW) radiation exposures: maximum specific absorption rates (SARs) of 0.04, 0.08 and 0.4 W/Kg, which translate into power densities of 100, 200 and 1,000 $\mu\text{W}/\text{cm}^2$, respectively. A fourth option is to take no official regulatory action (see box).

Which option EPA will finally select depends on numerous scientific and policy issues; in its *Federal Register* notice, the agency asks for public comments on how these issues should be resolved. Many key questions are unclear: EPA indicates that frequency-dependent power densities would be set based on the SARs but does not specify where, between 10 kHz and 100 GHz, the levels would change — that is, what is the resonant frequency range.

When and if EPA adopts — and the President approves — public exposure limits, formally called “Federal Guidance,” affected agencies will be responsible for implementing them.

EPA began work on the guidance in the late 1970s and, in 1982, asked for public comments on six questions related to standard-setting (see *MWN*, January/February 1983). In 1984, the agency was about to propose what is now called option 1 (100 $\mu\text{W}/\text{cm}^2$), but backed off in the face of opposition from EPA's policy office (see *MWN*, June and July/August 1984 and September/October 1985).

Since 1984, EPA's Office of Radiation Programs has waged an uphill battle against its own policy office and the Office of Management and Budget to propose the guidance. Delays followed delays and now, instead of proposing a single set of limits, EPA is again seeking public comments on a wide range of issues. According to the current timetable, EPA will issue a final guidance in December 1987. But it is more likely that the agency will be forced to issue a new proposal — and yet again ask for public comments — when it finally chooses one of the options. If so, the final guidance will be delayed at least until 1989.

Following a series of copyediting snafus, the EPA proposal finally appeared in the *Federal Register* on July 30 (51 *FR* 27,318) — more than six weeks after its release on June 12. Comments are due by October 28. EPA is sponsoring a public hearing September 22-23 at the GSA auditorium (18th and F Sts., NW) in Washington, DC.

Key Issues To Be Settled

At the heart of the decision on which option to select are three key questions: What margin of safety should EPA use to protect the public? How should it deal with non-thermal effects? and How should it resolve the question of RF/MW-induced carcinogenesis?

EPA states that adverse effects “begin to occur” between 1 and 4 W/Kg and that the exposure limits will be derived by applying a suitable safety factor — between 10 and 1,000 — “to compensate for unknowns and uncertainties.”

The public health significance of non-thermal effects, at SARs of less than 1 W/Kg, “is not well understood,” according to EPA: “The overall implications for human health of low-level non-thermal effects [are] not clear. . . further research is required to determine. . . whether they constitute a hazard to human health.”

EPA states that it “believes RF radiation should now be treated as a non-carcinogen.” Nevertheless, citing “some preliminary and unconfirmed studies,” principally the long-term exposure study at the University of Washington in Seattle, in which rats exposed to an SAR of 0.4 W/Kg had increased rates of tumors, the agency left the door open to changing its mind, noting that the issue of carcinogenesis “is not yet resolved and could affect EPA's assessment.”

Among the factors which will influence EPA's choice of the appropriate margin of safety are: (1) undetected sensitivities to radiation; (2) validity of animal data for gauging risks to humans; (3) lack of long-term exposure studies; (4) reliability of extrapolating from animal data to humans; (5) natural environmental and genetic variations among humans; (6) variations in environmental exposure conditions; (7) ill-characterized non-thermal effects; (8) lack of sensory mechanisms for warning against overexposure; (9) adequacy of the human thermoregulatory system; and (10) absence of a clear threshold for adverse effects.

Dealing with Shocks and Burns

“It is impractical to specify numerical electromagnetic field intensity limits that prevent all possible shock and burn effects,” according to EPA. Under the three specific options, EPA estimates the induced currents in a grounded individual at 3 MHz to be 45 mA, 247 mA and 553 mA for options 1, 2 and 3, respectively. EPA points out that only option 1 results in a threshold for RF burns of less than 100 mA, as proposed by the National Institute for Occupational Safety and Health.

EPA advises that, “as a minimum, low frequency fields

U.K.'s NRPB Proposes ELF, RF & MW Standards

The United Kingdom's National Radiological Protection Board (NRPB) has just published proposed standards for occupational and general public exposures to non-ionizing radiation below 300 GHz. For occupational exposures to radiofrequency (RF) and microwave (MW) radiation, NRPB recommends the same levels as those set by the American National Standards Institute (ANSI) in 1982; for occupational exposures at 50 Hz, it proposes 30 kV/m and 10 mT for the electric and magnetic fields, respectively. For all frequencies, general population exposure limits are no more than 40 percent of the occupational levels.

NRPB has invited comments on its proposal and plans to issue a final standard by early 1987. *Advice on the Protection of Workers and Members of the Public from the Possible Hazards of Electric and Magnetic Fields with Frequencies Below 300 GHz: A Consultative Document* (May 1986) is available from NRPB, Chilton, Didcot, Oxon OX11 0RQ, U.K.

Microwave News will publish a full report on the NRPB proposal in our next issue.

EPA's Four Options

Excerpts from EPA's Federal Register notice.

Option 1: Guidance Based on an SAR of 0.04 W/Kg. Controlling public exposure by limiting whole-body average specific absorption rates (SARs) to 0.04 watts per kilogram (W/Kg) for frequencies above 3 megahertz (MHz) and by limiting electric field intensity to 87 volts per meter (V/m) and magnetic field intensity to 0.23 amperes per meter (A/m) at frequencies below 3 MHz.

This option represents a "no effects" level by protecting against thermally-related health effects in humans, including most sensitive subgroups of the population. No measurable changes in core temperature would occur at this level nor would any thermoregulatory responses be initiated. This level is consistent with the usual practice of providing substantially more protective standards (here, by a factor of 10, when compared to, for example, the 1982 ANSI voluntary standard of 0.4 W/Kg) for the public than those recommended for occupational exposures. This level might be viewed as unnecessarily stringent in that the health protection provided may not be commensurate with its cost, particularly in view of the present uncertainties surrounding low-level and non-thermal effects.

Option 2: Guidance Based on an SAR of 0.08 W/Kg. Controlling public exposure by limiting whole-body average SARs to 0.08 W/Kg for frequencies above 3 MHz and by limiting electric field intensity to 275 V/m and magnetic field intensity to 0.73 A/m for frequencies below 3 MHz.

This option also effectively represents a "no effects" level by protecting against thermally related health effects in humans, including most sensitive subgroups of the population. No changes in core temperature should occur at this level nor should any thermoregulatory responses be initiated. Also consistent with the usual practice of generally providing more protective standards for the public than those recommended for occupational exposures, this level differs from Option 1 in that it is lower than, for example, the 1982 ANSI guide by a factor of 5 rather than a factor of 10, as given in Option 1. This option is similar to the Massachusetts standard, to the IRPA guideline in the resonant frequency range and to the exposure limits recently recommended by the NCRP. The agency is particularly interested in comment on this option, because 42 U.S.C. 2021(h) states that the administrator shall consult with the NCRP, among others, on radiation matters.

Option 3: Guidance Based on an SAR of 0.4 W/Kg. Controlling public exposure by limiting whole-body average SARs to 0.4 W/Kg for frequencies above 3 MHz and by limiting electric field intensity to 614 V/m and magnetic field intensity to 1.63 A/m for frequencies below 3 MHz.

This option should protect against thermal effects except in possibly more susceptible or sensitive people or possibly at high ambient temperatures and humidities. This level corresponds to the lower end of the range postulated to be associated with the onset of thermoregulatory responses in humans. Effects that occur below this level do not, for the most part, seem to be caused by generalized heating. The 1982 ANSI standard, set at this level, does not differentiate between occupational and public exposure but noted, "... these guides are offered as upper limits of exposure, particularly for the population at large." Various groups in the broadcasting industry have indicated to EPA their willingness to comply with a guideline at this level (letters placed in the central docket). The agency is particularly interested in comment on this option, because it is similar to the 1982 ANSI guide voluntarily adopted by much of the broadcast industry and is to be used by the FCC to determine the need for environmental impact analyses for new and renewal license applications.

Option 4: Conduct Other Activities in Lieu of Adopting Federal Radiation Protection Guidance for RF Radiation. In lieu of adopting Federal Guidance for RF radiation, establishing public awareness programs to distribute information on health effects and environmental measurements as well as provide technical assistance to states and federal agencies.

This is a nonregulatory option, and it would provide public health protection only as it is realized indirectly through the advice and technical assistance provided by EPA to federal agencies, states or industry. Taking no regulatory action at this time could permit any further regulatory action to be based on more refined biological, technical and economic analyses. For example, allowing more time for additional research to identify and quantify adverse health effects in the population may result in more improved risk estimates. It is not clear whether this approach will meet the perceived need of federal agencies, states or industry that have requested uniform federal exposure guidelines, and EPA seeks comments on this issue.

should be limited to intensities that prevent accident-causing startle reactions in ungrounded individuals who may momentarily contact grounded objects" in high RF fields.

In addition, the EPA proposal:

- Specifies no limits for peak intensities of pulsed fields;
- Suggests limits that are ten times less stringent for exposures of less than six minutes in any one hour, as long as the total energy absorbed is no greater than would be absorbed in one hour under continuous exposure;
- States that it is "impractical to distinguish between partial-body and whole-body exposures" and proposes that the limits apply to all exposures;
- Makes no special provisions for modulated fields because the scientific data "is not considered to be sufficiently developed";

- Excludes exposures from medical devices and consumer products.

EPA's economic analyses (see *MWN*, September/October 1985) show that even the most stringent controls (option 1) would have a relatively minor impact on federal RF/MW activities — EPA notes that even though some agencies differed with these estimates, one part of the Defense Department agreed.

Comments on the EPA options should be sent to: Central Docket Section (LE-131), U.S. EPA, Attention: Docket No. A-81-43, Washington, D.C. 20460.

The EPA Office of Radiation Programs recently moved. The new telephone numbers are: Dave Janes and Doreen Hill at (202) 475-9626; Norbert Hankin at (202) 475-9630. Their mailing address remains the same.

Wertheimer-Leeper ELF Exposure Estimates Confirmed

Reports from two ongoing epidemiological studies have confirmed the reliability of the coding scheme developed by Dr. Nancy Wertheimer and Ed Leeper to estimate human exposures to extremely low frequency (ELF) magnetic fields.

At the Bioelectromagnetics Society (BEMS) meeting in Madison, WI, in June, members of both study teams reported that detailed magnetic field measurements supported the Wertheimer-Leeper claim that residential exposures can be estimated by checking the wiring configuration near a given home. The two studies, funded by the New York State Power Line Project, are designed to test the Wertheimer-Leeper finding of a link between exposures to weak alternating magnetic fields and cancer (see *MWN*, September 1983).

Neither research group presented any results at BEMS on the key question of the possible relationship between ELF fields and cancer. These are expected to be ready for the Department of Energy and Electric Power Research Institute (EPRI) contractors review to be held in Denver, CO, in November.

Ground Currents

Bill Kaune of the Battelle Pacific Northwest Labs concluded that the "Wertheimer-Leeper method of wiring classification is correlated with residential magnetic fields" and that "our data are supportive of the idea, first suggested by Wertheimer and Leeper, that ground currents are a significant source of residential magnetic fields." Kaune pointed out that there is still considerable variability in magnetic fields within each category.

Drs. Frank Barnes and Howard Wachtel of the University of Colorado in Boulder reached a similar conclusion: on average, the magnetic fields are determined by sources outside the house, in a manner consistent with the Wertheimer-Leeper coding scheme. They too found that there can be substantial variation among different houses within a given class.

Asked whether he agreed with Kaune on the importance of ground currents, Wachtel told *Microwave News* that the greatest contributions to the magnetic fields come from outside the house and that they might be due to the ground currents. Household power does not affect the magnetic fields inside the home, he said.

In a telephone interview, Dr. David Savitz, an epidemiologist at the University of North Carolina in Chapel Hill who is in the process of analyzing the Colorado data, called the

new findings "a clear confirmation of the Wertheimer-Leeper exposure methodology."

This classification scheme has been criticized in the past. For instance, in an evaluation for EPRI, Daniel Roth, a consultant, reported that, "It is difficult. . . to accept Wertheimer and Leeper's conjecture that wiring configuration was a surrogate measure for magnetic fields. . ." (see *MWN*, May 1985).

Nevertheless, the method has won a considerable following — perhaps too great. Wertheimer and Leeper are now worried that others are using their coding system without first checking as to whether there is a correlation between local wiring and household magnetic fields in specific study areas. They are particularly concerned about the use of their technique in Europe (see "From the Field" on p.9).

VDT Pregnancy Studies Increase Uncertainty Over Possible Hazards

New and previously released epidemiological studies presented in May at a conference on video display terminals (VDTs) in Stockholm, Sweden, suggested that VDT work might adversely affect pregnant women, although most speakers dismissed the possibility of any risk.

Of the five major studies presented, four showed some positive associations. Two indicated increased rates of cardiovascular abnormalities in children born to women who used VDTs. A third suggested a tendency toward increased rates of spontaneous abortions among women who worked moderate amounts of time at VDTs — but not among those who worked long periods at VDTs. And the fourth found higher rates of abnormal pregnancies among VDT operators who were under stress.

Only one scientist reported an increased risk and advised against VDT work during pregnancy. Several researchers, while discounting their positive results as anomalous, called for further epidemiological studies.

Heart Defects In Sweden and Finland

A Swedish study of more than 4,000 births between 1980 and 1983 found 57 "significant malformations" among offspring of women with some or considerable VDT exposure, compared to 9 such malformations among babies of those with little or no exposure — yielding an odds ratio of 1.9, or a near doubling of the risk of defects. Lead researcher Peter Westerholm of the Swedish Trade Union Confederation admitted that this difference was of borderline statistical significance but concluded that there was no increased risk.

Among the 57 births involving serious defects, Westerholm and coworker Anders Ericson of Sweden's National Board of Health and Social Welfare found 12 cases of cardiovascular malformations, but they found no defects of this type in the control group.

The study team used computerized personnel records to identify job categories; employers and trade union officials subsequently estimated VDT use.

Westerholm reported that the group of women who spent moderate amounts of time doing VDT work had the highest rate — 3.4 percent — of significantly malformed babies, compared to 1.6 percent or less for those who did either more or less work. He called this finding "paradoxical," saying

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that the highest rate should have occurred among the women with the greatest exposures.

Dr. Karel Marha of the Canadian Center for Occupational Health and Safety in Hamilton, Ontario, responded from the audience that neither Westerholm's study nor any of the others controlled for "unintended" exposures to terminals — the amount of time a woman is not operating a VDT but is nonetheless working near one. "I would like to see an epidemiological study where exposure is well-defined relative to the location of the VDT," he said.

A second study also showed an increase in cardiovascular abnormalities among children born to women who used VDTs. Here again, the increase occurred only among part-time VDT operators. A group led by Dr. Kari Kurppa of the Institute of Occupational Health in Helsinki, Finland, reported 13 such birth defects among children of exposed women, compared to 8 among offspring of unexposed women (odds ratio of 1.6). Of the 13, 8 were among part-time workers (less than 4 hours/day), compared to only 3 among controls.

Kurppa's team had previously reported the results of this case-referent study in *The Lancet* (December 8, 1984) and in the *Scandinavian Journal of Work, Environment and Health*, 11, pp.353-356, 1985 (see *MWN*, January/February 1985 and March/April 1986, respectively).

The seemingly inconsistent finding of increased pregnancy

risks among operators who worked part-time at VDTs showed up yet again in the presentation by Canadian researcher Dr. Alison McDonald. Reporting on data first released in 1984, she pointed out an increased rate of abnormal pregnancies among moderate VDT operators but not among more regular users.

McDonald discounted her positive results, not only because the dose-response relationship was unusual but also because the rate of spontaneous abortions among non-VDT workers was lower than expected. She attributed the positive findings to recall bias and concluded that there is "no convincing evidence that use of VDTs during pregnancy increases birth defects or spontaneous abortions."

Dr. Henryk Mikolajczyk of the Institute of Occupational Medicine in Lodz, Poland, was the only speaker who concluded that VDTs pose a risk to pregnant women. His survey of 185 women, who worked for the Polish Airlines (135 women) or for a building construction bureau (50 women), indicated that work at VDTs under high-stress conditions may harm fetal development.

At the airline office, where the women experienced high levels of stress, the 89 VDT operators suffered 22 spontaneous abortions, compared to 8 among the 46 controls. At the other, low-stress office, however, none of the VDT users miscarried, while 5 of the controls reported spontaneous abortions.

VDTs, Stress and Smoking Linked to Problem Pregnancies

A new, two-part study indicates that VDT exposure, stress and smoking are all related to abnormal pregnancy outcomes, leaving open the possibility of a link between VDTs and birth defects and/or spontaneous abortions.

Swedish researchers Anders Ericson of the National Board of Health and Social Welfare and Dr. Bengt Kallen of the University of Lund concluded that, "The question of a possible reproductive hazard associated with video screen work is by no means finally settled." They believe that the possible risk of birth defects is greater than that of spontaneous abortions, though they doubt that VDT work increases either significantly.

After examining national birth registry and medical records of approximately 10,000 pregnancies, Ericson and Kallen reported indications of an increased risk of problem pregnancies among women with the greatest VDT exposure. Interestingly, of the three job categories classified as "high" exposure groups — computer personnel, travel agency clerks and insurance clerks — computer personnel suffered a markedly higher rate of significant infant malformations than did the other two groups, accounting for the increase of the whole "high" exposure group relative to the "low" and "medium" groups.

Ericson and Kallen also compared pregnancy outcomes from 1976-1977 to those from 1980-1981 and observed "faint indications" of increased spontaneous

abortion and malformation rates in the latter period, when VDTs were more widely used. The number of spontaneous abortions in 1976-1977 was lower than expected, the authors warned.

Investigating further, Ericson and Kallen ran a case-control study of 522 cases of significant birth defects and spontaneous abortions compared to 1,032 controls. As in part one, they analyzed the data according to low, medium and high VDT exposures.

They found a statistically significant, dose-dependent association between VDT work and birth defects but cautioned that they were unable to separate VDT work from other variables. "If a relation between birth defects and video screen work is actually present," they wrote, "it is most likely an effect of stress at work, perhaps combined with smoking."

The researchers noted that they included only spontaneous abortion cases for which women were hospitalized and thus may have excluded early miscarriages; they also cautioned that the data collected by questionnaires in the second part of the study may have suffered from recall bias.

The study papers, "An Epidemiological Study of Work with Video Screens and Pregnancy Outcome: I. A Registry Study" and "II. A Case-Control Study," appeared in the *American Journal of Industrial Medicine*, 9, pp.447-457 and pp.459-475, respectively, 1986. They were originally published last year in Swedish.

Relaxation of ANSI RF/MW Safety Standard Proposed; Literature Review Incomplete

The first draft revision of the 1982 American National Standards Institute (ANSI) safety standard for human exposures to radiofrequency and microwave (RF/MW) radiation includes a number of proposals to relax the limits.

At a two-day meeting in Madison, WI, June 6-7, Dr. Kristian Storm, chairman of subcommittee C95.IV, which is rewriting the standard, outlined some of the proposed changes. These include:

- Doubling the allowed exposure levels above 3 GHz from 5 mW/cm² to 10 mW/cm² and extending that limit from the present 100 GHz to 300 GHz.
- Adding protection against shock and burns, while loosening the allowable exposures to magnetic fields at low frequencies and extending the standard's applicability down to 3 kHz.
- Increasing the limits for partial-body exposures from the present 8 W/Kg possibly up to 24 W/Kg.
- Exempting medical diagnostic devices.

The specificity of the proposed changes caught many members of the subcommittee by surprise because the review and analysis of research papers — the basis for the new standard — are incomplete. Of the 310 recent papers that the subcommittee has identified as possibly germane to the revision, only 43 have so far been evaluated.

Speaker after speaker said it was too early to talk about biological thresholds for radiation effects because the various working groups have not completed the evaluations. Dr. Joe Lary of the National Institute for Occupational Safety and Health asked, "How are we going to get a consensus if the literature review isn't done?"

"We must proceed, time is of the essence," Storm replied. Under ANSI rules, all standards must be reaffirmed or revised every five years; action is therefore due by 1987.

In a series of interviews with *Microwave News*, most subcommittee members said that they agreed with Lary. Jules Cohen, a consultant to the broadcasting industry, said "It is too early to vote on biologically-based limits." And Dr. John Monahan of the Food and Drug Administration (FDA) commented, "It's all backwards." Storm was supported by the subcommittee's secretary, Dr. John Osepchuk of Raytheon, who said that there was no need to wait for the literature review because we "more or less know where things should go."

The subcommittee approved the extension of the standard's frequency limits down to 3 kHz and up to 300 GHz but did not vote on any exposure limits.

A Two-Tier Standard

There was extended debate on whether the standard should be changed to recommend different limits for workers and for the general public, prompted in large part by a letter from FDA's Dr. Mays Swicord, who was unable to attend the meeting. Swicord wrote, in part: "Without convincing and well-substantiated arguments to the contrary, different exposure limits should be adopted" for each group.

He noted that the International Radiation Protection Association (IRPA) and the National Council on Radiation Protection and Measurements (NCRP) have adopted two-tier standards, in contrast to the 1982 ANSI standard.

Dr. Carl Sutton, a medical doctor, favored a two-tier standard as "the only way to go," while Ralph Justus of the National Association of Broadcasters argued against it. Dr. Bud Appleton, a consultant, said that there was no need for two standards because there are no chronic effects from exposure. Others, like Dr. John Bergeron of General Electric and Dr. Elliot Postow of the Naval Medical R&D Command, suggested that the subcommittee should only recommend an occupational standard. But Dr. Quirino Balzano of Motorola warned that if ANSI fails to set a population standard, everybody will use the recently released NCRP standard that specifies fivefold stricter limits for the public than for workers (see *MWN*, May/June 1986).

The problem of how to handle the threat of shock and burns at low frequencies swayed many in favor of a dual standard. While workers could be trained to minimize these risks, most of the subcommittee agreed that this would be an impractical solution for the public.

The final compromise was to adopt the concept of different standards for workers and for the public, while leaving the door open to the possibility that the subcommittee may recommend the same limits for both groups in specific frequency bands. When the question was called for a vote, some subcommittee members, such as Dr. Eleanor Adair of the John Pierce Foundation, asked whether it was appropriate to vote when the literature data base was incomplete. Storm insisted it was appropriate, saying, "We have a mandate and time is short."

Two Options for Shocks and Burns

The most detailed discussion of new research focused on the threat of shocks and burns at low frequencies. Awareness of these risks stems from research by Drs. Om Gandhi of the University of Utah in Salt Lake City and Bill Guy of the University of Washington in Seattle (see *MWN*, July/August 1985 and the "Biological Effects" Update on p.10). Each offered a different way of minimizing these hazards, however, arguing that the other's proposal was too strict.

Gandhi suggested tightening the time-averaged power density limits by a factor of ten in the 300 kHz to 300 MHz band; Guy called this "ridiculous" because the problem only exists for high power sources. On the other hand, Guy favored a maximum body current of 50 milliamps (mA) and training workers to protect themselves. Gandhi questioned how such a limit could be enforced and said that this approach was "overly restrictive" because a 50 mA limit represented a tightening of the electric field standard limit by a factor of 16 and of the power density by a factor of 256.

Richard Tell of the Environmental Protection Agency noted that, below 300 MHz, the new electric field standard for the general population may have to be tightened by more

than the factor of ten proposed by Gandhi. And Storm observed that "There is a clear need to do something at low frequencies." But no consensus emerged.

Proposal for 10 mW/cm² Standard Above 3 GHz

Guy and Gandhi also disagreed on the preferred limits at higher frequencies. Gandhi said that he was against doubling the exposure limit to 10 mW/cm² above 3 GHz, while Guy said that he was not taking any side. Raytheon's Osepchuk said that the proposal was based on the desire to match the infrared (IR) standard of 10 mW/cm² above 300 GHz.

Guy argued that temperature distribution at 3 GHz is very similar to that associated with IR radiation. Gandhi countered that IR and millimeter waves are very different because millimeter waves can penetrate clothing while IR cannot and that the two types of radiation will therefore cause very different thermal loads.

Some of those present, like Gandhi, questioned the origin of the IR 10 mW/cm² standard. Only the ANSI laser standard of 10 mW/cm² was mentioned as the possible source of the IR limit.

NIOSH's Lary said that he did not think that 10 mW/cm² would be sufficiently protective below 30 GHz. Motorola's Balzano agreed.

Australian Power Line Dispute

A controversy over the siting of a power line is raging in the state of Victoria, Australia. At issue is an 8 km, 220 kV, 50 Hz line that would run between Richmond and Brunswick at a cost of \$12 million (Australian).

In an effort to quell public opposition, the state government of Victoria brought in Dr. H.B. Graves, formerly of Pennsylvania State University in University Park and now a private consultant based in Corpus Christi, TX, to review the health risks associated with power line radiation. In a report submitted in March, Graves concluded that adverse public health effects "have not been established."

Area residents were not appeased. Led by Ian Macmillan of both the Collingwood Community Health Center (CCHC) and the Collingwood Residents Association (CRA), they charged that Graves's report is biased: "From the evidence available to us, it appears that Dr. Graves is aligned to one side of a now highly polarized debate, and should not hold such an influential position in this case."

The proposed line would replace an existing 66 kV line and would generally follow the present route through several communities in the Yarra River and Merri Creek valleys. In a 1 km stretch through a populated area, it would be placed underground. Also, the line would cross public school grounds. Last fall, concerned parents stepped up their opposition to the project when they learned of the \$25 million award against Houston Lighting and Power Co. (HL&P) for siting a power line on school property (see *MWN*, November/December 1985).

In June, CCHC and CRA flew in Dr. Jerry Phillips of the Cancer Therapy and Research Foundation in San Antonio, TX, to rebut Graves's testimony. Phillips had testified at the HL&P trial.

No one raised the question of how to handle the results of the long-term, chronic-exposure study from Guy's lab suggesting that microwaves can promote cancer (see *MWN*, July/August 1984 and March 1985).

Are Committee Members Liable?

At a meeting of the full C95 committee on June 4, the panel discussed at length whether members of standard-setting committees are liable for their actions — an issue which gained widespread significance in 1982 when the U.S. Supreme Court ruled that the American Society of Mechanical Engineers was liable for a multi-million dollar award as a result of the unethical conduct of one of its committee members in developing a boiler standard (see *MWN*, June 1982).

Both Bertram Stanleigh of the IEEE and Steve Caine of the Navy, the two sponsors of the C95 committee, said that only their designated representatives were protected. Raytheon's Osepchuk argued that the IEEE should indemnify all the committee members. Stanleigh said that he would advise the IEEE management of the request but doubted there would be a change of policy.

Some members of the subcommittee rewriting the RF/MW safety standard abstained from voting out of concern over possible later liability.

The final decision on whether to build, delay or abandon the line lies with Robert Fordham, the Victoria Minister for Industry, Technology and Resources. He is expected to make an announcement in August.

Graves's report, *A Review of the State Electricity Commission of Victoria (SECV) Transmission Line and Station Design Practices in Relationship to the Health and Safety Effects on People*, was submitted to David White, the Victoria Minister for Health.

DoD's TEMPEST Program Badly Run, GAO Reports

Poor management of the Department of Defense's (DoD) TEMPEST program has resulted in millions of dollars of unnecessary expenditures and may have led to the disclosure of classified information, according to the General Accounting Office (GAO), a congressional investigative office.

The TEMPEST program, intended to protect classified electronic information, uses special shielding to prevent the unauthorized reception of stray radiation signals. The annual cost of TEMPEST is unknown, but GAO estimates that it is hundreds of millions of dollars.

In its new report, GAO found that DoD "often" failed to evaluate the need for TEMPEST measures, leading the department, in some instances, to "spend more money than necessary to protect classified information." Conversely, the lack of evaluations "could also result in insufficient protection being given to classified information."

A GAO spokesperson told *Microwave News* that it found no evidence of actual leaks.

GAO also charged that the Air Force, the Army and the Navy have been "slow" to implement security procedures issued in 1984 (see *MWN*, September 1984): As of June

HIGHLIGHTS

1986, none of the three services had fully implemented the January 1984 National Communications Security Instruction (NACSI) 5004, which sets out TEMPEST procedures. In addition, GAO said that the services had administered the procedures separately and inconsistently and that all three had "usually" failed to inspect contractors' equipment to ensure TEMPEST compliance.

Enforcement Inadequate

Enforcement of TEMPEST requirements in DoD contracts is inadequate, GAO concluded. DoD's Defense Investigative Service (DIS), which is authorized to inspect contractors' facilities, cannot disapprove a system for TEMPEST violations. Instead, DIS must notify DoD contracting officers, some of whom do not know that they are responsible for enforcement and consequently fail to act when notified.

GAO recommended that the Secretary of Defense implement a new TEMPEST-related security policy and consider consolidating enforcement in a single office.

The report, *DoD TEMPEST Protection: Better Evaluations Needed to Determine Required Countermeasures*, was prepared for Congressman Glenn English (D-OK), chairman of the subcommittee on government information, justice and agriculture of the House Committee on Government Operations. A subcommittee spokesperson said that Congressman English is not planning hearings or any other follow-up work.

NSA Objection

The National Security Agency (NSA), which manages TEMPEST-related activities for DoD, objected to the release of the study but did not place a security classification on it. According to GAO, NSA "believes that, although not technically classified, this report contains extremely sensitive information, which, if made public, would be detrimental to the United States Government TEMPEST program." The subcommittee spokesperson told *Microwave News* that Congressman English had requested an unclassified report.

Vernon Microwave Radiation Levels in Picowatt Range

The residents of Vernon Township, New Jersey, are exposed to "significantly lower levels" of electromagnetic fields than most Americans, according to the Environmental Protection Agency (EPA). In measurements taken last November, EPA found that the average radiation levels were approximately 226 picowatts per centimeter squared (pW/cm^2), or $226 \times 10^{-6} \text{ uW}/\text{cm}^2$, and, at some sites, the levels were below the detection limits of the measurement equipment. The maximum reading in the town was $2,810 \text{ pW}/\text{cm}^2$.

Vernon has been the center of a continuing controversy after a cluster of Down's Syndrome cases was identified among babies born to local residents (see *MWN*, May 1985). Citizens Against the Tower (CAT), a Vernon citizen's group, blames the cluster on exposures to microwaves because of the high concentration of radiation sources in the town: there are three satellite stations in Vernon with more than 15

uplink antennas and numerous point-to-point transmitters.

The highest radiation level measured by EPA was $60 \text{ uW}/\text{cm}^2$ in the 6 GHz band on a hillside on RCA property near its satellite station. EPA found that the power density fell to less than $10 \text{ uW}/\text{cm}^2$ beyond 650 feet from the antenna. New Jersey has a $5,000 \text{ uW}/\text{cm}^2$ standard at this frequency.

According to EPA, the measurements have an uncertainty of up to 3 dB — that is, they could be either too high or too low by a factor of 2.

CAT criticized the report for failing to provide a complete survey of the radiation pattern in the town. "They did not do what was necessary," CAT's Elise Kreindler said in an interview. "The report does not in any way begin to answer the question of disease pattern and its possible linkage to microwaves."

In its report, EPA admits to having done less than CAT had originally asked: "Inclement weather (rain, sleet, snow, icy roads) and time constraints limited the number of community measurement sites to 25."

In an "Analysis" of the EPA report, Dr. Robert Becker and Adam Becker called the results "completely inadequate" and the report itself "significantly flawed." They were especially critical of the limited number of measurements: "It is rather like taking thimblefuls of dirt from 25 randomly selected areas at Love Canal to assess the chemical contamination in the entire area." Robert Becker is the author of *The Body Electric: Electromagnetism and the Foundation of Life*.

Sidelobes Missed?

One of the unexpected findings in the EPA report is a power density of $2,810 \text{ pW}/\text{cm}^2$ in the 11 GHz band measured at the Rolling Hills Primary School, located near the American Satellite facility. This reading, EPA believes, was due to a terrestrial point-to-point relay.

The Beckers attributed the reading to a side lobe from a low power relay, which indicated to them that there must

Our Electrical Environment

Fifty to 100 lightning bolts hit the earth every second, killing hundreds of people each year, causing forest fires, threatening aircraft and damaging sensitive electronic equipment. They are the leading cause of power failures, such as the one that blacked out New York City in 1977.

Lightning is the most obvious manifestation of our complex electrical environment, which extends from the million amp currents that flow in the upper atmosphere down to the telluric currents in the oceans.

What we know about all this — and what we don't — is the subject of a new, major report by the National Academy of Science-National Research Council's Geophysics Study Committee. *The Earth's Electrical Environment*, a 263-page, well-illustrated volume, consists of 16 chapters, written by leading researchers in the field. It is available for \$26.95 from the National Academy Press, 2101 Constitution Ave., NW, Washington, DC 20418.

be side lobes from the higher power earth stations, which EPA failed to identify due to its limited survey of the town.

Dr. Jeremy Raines, a consultant based in Potomac, MD, also voiced concern over the possibility that, in light of the 2,810 pW/cm² reading, EPA may have missed sites with higher power densities. In a letter to CAT, Raines contrasted what he called "very strong" signals from the satellite dishes with the contention, voiced at Vernon town hearings, that they were imperceptible or unmeasurable.

Advisory Committee

The radiation measurements were prompted, in part, by a November 1985 recommendation from the Centers for Disease Control (CDC) in a report confirming the existence of a Down's Syndrome cluster (see *MWN*, November/December 1985). CDC also advised the state's Department of Health to set up a scientific advisory panel with representatives selected by the state and by CAT.

The panel is expected to hold its first meeting in August. CAT has selected Dr. Ruey Lin of the Maryland Department of Health and Mental Hygiene to be its nominee to the panel. The New Jersey Bureau of Radiation Protection will be represented by Ron Peterson of AT&T Bell Labs.

As the microwave debate continues, Vernon has been faced with another radiation controversy. The state Department of Environmental Protection has selected the town for the burial of 5,000 drums of radon-contaminated soil. Vernon Mayor Victor Marotta was quoted by UPI as telling 5,000 protesters that local officials "will do what they have to do" to block the shipment. The town is in the process of appealing the decision in the state courts.

A copy of the EPA report, *An Investigation of Microwave and Radiofrequency Radiation Levels in Vernon Township, New Jersey, November 10-16, 1985*, June 1986, is available from Debby Wenke, Bureau of Radiation Protection, 380 Scotch Road, Trenton, NJ 08628, (609) 530-4003.

FROM THE FIELD

Wertheimer and Leeper: Estimating ELF Exposures

Reprinted below is a May 29th memo by Ed Leeper and Dr. Nancy Wertheimer on the Necessity for Taking Representative Magnetic Field Measurements in the Study Locale Before Using Wiring Configuration as an Indicator of Field Exposure for an Epidemiological Study.

This memo was prompted by the use of the Leeper-Wertheimer coding scheme by researchers in Europe. For a copy of Leeper's memo on Details of Wiring System Features with Particular Reference to U.S./European Differences, send a self-addressed, stamped envelope to Leeper, Salina Star Route, Boulder, CO 80302. See also story on p.4.

Since we published, in 1979, our first work linking cancer incidence with "wiring configuration," we have been pleased to see several other research groups using similar methods to study the epidemiology of ELF magnetic fields. We feel that wiring configuration is a fruitful way to assess long-term ELF magnetic field exposure in the home environment. Perhaps it is even the "best" or "only" way, especially when what is needed is to assess exposure at some past time.

However, we have been disturbed to see instances where the wiring configuration technique has been used without sufficient attention to the difficulties that may be expected.

The central problem is that *production of significant ELF magnetic fields by the electrical distribution system or home wiring is extremely dependent on details of that distribution system or home wiring*. Within one geographical area there can be enough standardization of wiring practices (because of building codes and the presence of only a single electric utility) to allow a statistically valid link to be discovered between easily determined physical features of the distribution of home wiring systems and the expected level of long-term ELF magnetic field exposure in the home. But wiring practices in another geographical area may be sufficiently different to require establishing that link all over again in a new way.

As we travel, even within this country, we are struck by how differently electrical distribution is implemented by power companies in different areas. But in *other* countries, the differences that we understand to exist are enormous — particularly in the all-important area of grounding practices.

In addition, several examples have come to our attention of home wiring practices used in other countries that are different from those used here and that would or could cause fields from home wiring to dominate the field exposure in the home.

Within the U.S., uniform wiring codes would seem to assure that other workers will find what we did: that wiring within the home rarely contributes substantially to the general magnetic field exposure within that home. But that hypothesis should not be assumed to be true in another country, without testing.

In any case, wherever work is done, *it is essential to take representative magnetic field measurements to establish a link between physical features ("configuration") and expected magnetic field exposure that will be valid for the locale in which the epidemiological research is to be done*. That point cannot be overemphasized.

Our own work has from the beginning included a program of measurements to identify physical features typically associated with elevated magnetic fields. For a variety of reasons, we find that this cannot be done by theory alone.

It was perhaps a mistake on our part that in our early publications on wiring configuration we did not (for reasons of space) emphasize the measurement-based empirical procedure we used to determine the particular wiring configurations we chose to compare with cancer rates. That was partly because at that time we took the conservative position that we had determined an apparent link only between certain wiring configurations and cancer. We were perhaps being overly cautious in doing that, since in fact those configurations were selected for their typical production of high magnetic fields.

In any case, seven years later and thanks to a variety of related work, the hypothesis to be tested is now rather clearly one of whether magnetic field exposure per se is linked to cancer. And that can be done using wiring configuration or the presence of other physical features only if representative measurements are taken in the locale of the study to determine what physical features are associated, *in that locale*, with elevated magnetic fields. Big wires don't always make big fields, and relatively small wires can make surprisingly strong fields in certain situations. In addition, especially outside the U.S., fields from wiring source[s] within the home may "swamp out" fields from outdoor distribution system wiring.

BIOLOGICAL EFFECTS

Calming with Microwaves. . . Pulsed microwaves at power densities as low as 50 $\mu\text{W}/\text{cm}^2$ can decrease aggressive behavior in rats, according to Drs. Allan Frey and Jack Spector of Randomline, Inc., in Huntingdon Valley, PA. In a paper scheduled to appear in the June issue of *Aggressive Behavior* (Vol. 12, No. 4), Frey and Spector report that rats exposed to 1.3 GHz radiation with a pulse width of 0.5 msec, a repetition rate of 1,000 pps and average incident power densities of 50 and 100 $\mu\text{W}/\text{cm}^2$ were significantly less likely to assault other rats, as measured by a well-defined method for quantifying aggressive behavior. Exposures at 20 $\mu\text{W}/\text{cm}^2$ did not affect the rats. Frey and Spector also found that the "pulse width did not appear to be critical." The results are consistent with Frey's hypothesis that low intensity electromagnetic energy can influence the dopamine-opiate systems in the brain (see *Journal of Bioelectricity*, 3, pp. 373-383, 1984).

Induced Currents at 3-60 MHz. . . In our July/August 1985 issue, we reported on the latest research by Professor Om Gandhi and coworkers at the University of Utah in Salt Lake City showing that exposure to radiation in the 3-60 MHz band, at levels allowed under the 1982 ANSI safety standard, can result in high SARs and large currents flowing through the ankles and feet of barefoot individuals. These results have now been published in the August 1986 issue of the *IEEE Transactions on Biomedical Engineering*. Gandhi writes that, "The highest foot current for a 1.75 m human adult is observed at about 40 MHz with a value on the order of 12.7 mA/(V/m)." At 40 MHz, the ANSI standard is 61.4 V/m (1 mW/cm²), which would result in a 780 mA foot current and an SAR of 243 W/Kg in the ankles. For five- and ten-year-olds, the maximum ankle SARs are 534 W/Kg at 62.5 MHz and 371 W/Kg at 50.7 MHz, respectively. (ANSI specifies a maximum partial-body SAR of 8 W/Kg. See the report on the ANSI subcommittee's deliberations on this new data on p. 6.) Gandhi's team also studied the currents induced from working at RF sealers. Douglas Hill and Alan Walsh of the Defense Research Establishment in Ottawa have estimated lower SARs through the ankles (see "Radiofrequency Current Through the Feet of a Grounded Human" in the February 1985 *IEEE Transactions on Electromagnetic Compatibility*.) Gandhi ascribes the Canadians' low values to their overly simplified model of the human ankle.

COMPATIBILITY & INTERFERENCE

Ovens and DBS. . . Direct broadcast satellites (DBS) promise to change the way people tune in television signals, especially in Europe and Japan, but their reception may be hurt by another household appliance, the microwave oven. Most ovens now operate at 2.45 GHz, and emissions of their fifth harmonic could therefore interfere with downlink satellite transmissions in the 12 GHz band. A team from Hitachi's Mobara Works in Japan has been studying ways of suppressing emissions from an oven's magnetron by fitting a choke to its output antenna. In a paper presented at the *21st Annual Microwave Power Symposium* in Memphis, TN, at the end of July, Akikazu Harada and coworkers indicated that they

have succeeded in reducing the fifth harmonic by 20 dB and predicted that their suppression methods will soon be incorporated in the mass production of magnetrons for ovens; this and more may be necessary if new, stringent limits are adopted for ISM equipment. They pointed out one tradeoff, however: reducing the fifth harmonic can result in higher emissions of other harmonics. An abstract of their paper appears in the *Journal of Microwave Power*, 21, p. 90, 1986.

ARRL Petition Denied. . . The FCC has turned down the American Radio Relay League's (ARRL) April 22 request for mandatory EMI susceptibility labeling of home electronics equipment (see *MWN*, March/April 1986). In rejecting the ARRL's petition, FCC Chief Engineer Thomas Stanley reasoned that determining which of two labels to apply — one for equipment with EMI controls and one for equipment without — would require the FCC to develop and implement EMI susceptibility standards. The FCC has decided instead to maintain its position of "minimum regulatory involvement," relying on manufacturers to comply with voluntary guidelines. The ARRL has already filed a petition for reconsideration.

The Long Electronic Arm of the Law. . . Captain Midnight, the video vandal who overrode a Home Box Office (HBO) movie in April to protest the network's decision to scramble its signals, has been caught. The FCC got its man — John MacDougall, a 25-year-old Floridian who owns a satellite dish sales company — with the help of some electronic sleuthing. Because only a handful of the 2,000 U.S. satellite uplink stations are large enough and powerful enough to override the HBO signal, and because only a few have the right type of character generator, federal sleuths narrowed their search to less than a dozen sites. Then, with the help of a hot tip from an overheard telephone call, they narrowed in on the Central Florida Teleport at Ocala. MacDougall surrendered on July 22 and plea-bargained a sentence of one-year unsupervised probation and a \$5,000 fine. HBO Chairman Michael Fuchs, obviously satisfied with the FCC's feat, warned that his company has taken "certain precautions" to discourage future video intruders. Nevertheless, satellite experts have a whole new set of worries: What, they ask, if a terrorist could order a satellite to leave its orbit and get lost in space?

Supersecret EMI. . . In Key West, FL, several would-be broadcasters trying to start a TV station on channel 3 have met stiff opposition from the Navy, according to the July 18 *Wall Street Journal*. The Navy apparently operates a communications center on the island, but it is so secret that the Navy refuses to even discuss the facility, except to say that the TV signals would interfere with it. Some people speculate that the base is a listening post for signals from Cuba. After meeting with the Navy, the FCC suggested that the station move to channel 8. To enable such a change, however, an educational station 60 miles away in Marathon, FL, would have to switch from channel 9 to channel 3.

New on the Market. . . KeyTek Instrument Corp. has developed two new surge generators (Models 587 and 587-Plus) for simulating AC power line transients to comply with ANSI C62.41-1980. The units, which cost \$19,870 and \$22,935, respectively, are described in the company's Bulletin

587/1, available free from Mike Hopkins, KeyTek Instrument Corp., 12 Cambridge St., Burlington, MA 01803, (617) 272-5170. . . The Southwest Research Institute (SwRI) in San Antonio, TX, has built a 16x16x28-foot anechoic chamber for EMI testing at frequencies as low as 30 MHz. For more information, contact William McGinnis, manager, SwRI EMC Services, 6220 Culebra Rd., PO Drawer 28510, San Antonio, TX 78284, (512) 684-5111. . . Amplifier Research has a new high-power horn antenna designed to reduce the problem of field strength loss at high frequencies. Model AT4001, which can operate in the frequency range 400-1,000 MHz, with an input power of up to 1,000 watts, is designed for shielded-room and open area RFI susceptibility and emission testing. The unit costs \$2,000 and is available from Amplifier Research, 160 School House Rd., Souderton, PA 18964, (215) 723-8181. . . Electro-Metrics has improved its TEMPEST Test Receiver. The new NTR-51C is faster, lighter and smaller than the old NTR-51, while meeting or exceeding the requirements of NACSIM 5100A. Contact: Electro-Metrics Marketing Dept., 100 Church St., Amsterdam, NY 12010, (518) 843-2600. . . And, Systematics General of Vienna, VA, has adapted an Apple Macintosh computer to comply with TEMPEST standards. According to the announcement in the July 28 *InfoWorld*, the TEMPEST shielding increases the weight of the Macintosh from 17 to 26 pounds.

MEASUREMENT

New from NBS. . . Here are some of the latest reports and papers from the National Bureau of Standards. . . From their Technical Note series: • *A Radiofrequency Power Delivery System: Procedures for Error Analysis and Self-Calibration*, by Motohisa Kanda and R. David Orr (TN 1083). Order No. 003-003-02610-1, \$1.00, prepaid, from U.S. Government Printing Office (GPO), Washington, DC 20402. • *Site Attenuation*, by R.G. FitzGerrell (TN 1089). Order No. 003-003-02708-1, \$2.00, prepaid, from GPO. • *Interelement Interactions in Phased Arrays: Theory, Methods of Data Analysis, and Theoretical Simulations*, by Lorant Muth (TN 1091). Order No. 003-003-02715-4, \$2.00, prepaid, from GPO. • *Direct Measurement of the Electric Field of a Laser Pulse - Theory*, by Eric Johnson, Jr. (TN 1084). Order No. 003-003-02697-2, \$2.25, prepaid, from GPO. . . Recent bibliographies and compilations: • *Metrology for Electromagnetic Technology: A Bibliography of NBS Publications*, edited by Kathryn Kline and Mary DeWeese (NBSIR 85-3029). Order No. PB 86-130234, \$11.95, prepaid, from National Technical Information Service (NTIS), Springfield, VA 22161. • *A Bibliography of the NBS Electromagnetic Fields Division Publications*, edited by Kathryn Gibson, Jessie Page and Charles Miller (NBSIR 85-3040). Order No. PB 86-191947, \$11.95, prepaid, from NTIS. • *Precision Measurement and Calibration: Electricity*, edited by A.O. McCoubrey (SP 705). Order No. 003-003-02699-9, \$23.00, prepaid, from GPO. . . New near-field publications: • *Development of Near-Field Test Procedures for Communication Satellite Antennas, Phase I, Part 1*, by Allen Newell and Andrew Repjar (NBSIR 85-3031). Order No. PB 86-1643577, \$11.95, prepaid, from NTIS. • *An Efficient and Accurate Method for Calculating and Representing Power*

Density in the Near-Zone of Microwave Antennas, by Richard Lewis and Allen Newell (NBSIR 85-3036). Order No. PB 86-181963/AS, \$9.95, prepaid, from NTIS. . . Also of interest: • *Out-of-Band Response of Reflector Antennas*, by David Hill (NBSIR 85-3021). Order No. PB 85-224475/AS, \$11.50, prepaid, from NTIS. • "Simple Approximate Expressions for Higher Order Mode Cutoff and Resonant Frequencies in TEM Cells," by Perry Wilson and Mark Ma in *IEEE Transactions on Electromagnetic Compatibility*, 28, pp.125-130, 1986.

MEDICAL APPLICATIONS

Pacemaker EMI. . . RF interference from a magnetic resonance imaging (MRI) scanner operating at 0.5 tesla caused total inhibition of atrial and ventricular output in three DDD pacemakers and dangerous atrial pacing in a fourth unit, according to Dr. Jay Erlebacher and his coworkers at the New York Hospital-Cornell Medical Center in New York City. In their paper, which appears in *The American Journal of Cardiology*, 57, pp.437-440, 1986, they conclude that "MRI scanning should be avoided in patients with implanted DDD pacemakers."

MEETINGS

BRAGS in Holland. . . The program for the 6th Annual Meeting of the Bioelectrical Repair and Growth Society (BRAGS) has been finalized and it promises an international cast. Researchers from Belgium, Bulgaria, England, Israel, Italy, Poland, the Soviet Union, Sweden, West Germany, Yugoslavia, as well as from the U.S. and Canada, are scheduled to present papers in Utrecht, Holland, October 19-22. Special rates at the official conference hotel (Holiday Inn) will be available until September 1. And KLM is offering special airfares: in the U.S., contact Gerda Cooper at Rosenbluth's Travel, (800) 233-3158; elsewhere, contact KLM directly and mention BRAGS.

IRPA-7 in 1988. . . Non-ionizing radiation, usually the poor relation to ionizing radiation, is slowly gaining respect. At the 7th International Congress of the International Radiation Protection Association (IRPA) to be held in Sydney, Australia, April 10-17, 1988, many of the sessions will address both types of radiation - the first time in IRPA history that they will be considered together. The week before the congress (April 5-8), there will be a workshop on *Non-Ionizing Radiation Biological Effects, Protection and Standards* in Melbourne. This review session will cover all types of non-ionizing radiation from ELF to microwaves to UV to IR and visible light, as well as lasers. The overall theme of the congress will be "Radiation Protection Practice." Papers are now being invited for oral and poster presentations, with abstracts due by March 15, 1987. For more information on both IRPA-7 and the workshop, contact J.C.E. Button, Health and Safety Division, Australian Atomic Energy Commission, Private Mail Bag, Sutherland, NSW 2232, Australia.

Complying with RF Broadcasting Rules. . . The National Association of Broadcasters (NAB) is sponsoring a one-day seminar on how to comply with RF radiation regulations at the *Radio'86* convention in New Orleans, LA. The September 10 seminar will cover the FCC rules, measure-

UPDATES

ment techniques, FM antenna patterns, occupational exposures and tower maintenance, as well as "dealing with zoning commissions" and "public inquiries and the press." The speakers will be: Jules Cohen, Robert Culver, Thomas Fitch, Ralph Justus, Ronald Rackley, Ruth Rosenberg, Richard Tell and Barry Umansky. Registration costs \$150 for NAB members and \$250 for others. Those attending *Radio'86* can save \$100. For more information, contact NAB's Dept. of Science and Technology, 1771 N St., NW, Washington, DC 20036, (202) 429-5346.

MILITARY SYSTEMS

EMPRESS II Developments . . . The Navy has reported further delays in preparing a supplemental draft Environmental Impact Statement (EIS) on its second Electromagnetic Pulse Radiation Environment Simulator for Ships (EMPRESS II). Already more than a year overdue, the report is now scheduled for release in November; following public review, it will be revised, with the final EIS due next April, according to a Navy spokesman. The Navy, which plans to site EMPRESS II on Chesapeake Bay in Maryland, met with state officials on July 17 as part of a continuing series of discussions on its biological monitoring program. The NAVY plans to have EMPRESS II operational in 1990.

OVENS

Burn Injuries . . . As microwave ovens continue to grow in popularity, more and more burns will result from their misuse, warns a researcher at the Shriners Burns Institute in Cincinnati, OH. The results of a three-nation (U.S., U.K. and Canada) survey indicate that the most frequent cause of injury from microwave ovens is scalding by hot liquids or vapors — in particular, infants are injured by overheated baby bottles. "Haste and an attitude that microwave ovens are safer . . . result in injury," explains Dr. Matthew Maley. Oven manufacturers, he notes, do not include warnings about bottle burns in operating manuals and, although bottle manufacturers do warn of such dangers, many parents nevertheless heat bottles in their microwave ovens. Other causes of injuries include exploding eggs, contact with hot items and exposure to microwaves when ovens fail to shut off after their doors are opened. An 11-page report on Maley's survey findings is available from Risk Management, Shriners Burns Institute, 202 Goodman St., Cincinnati, OH 45219. A letter based on the report appeared in the May 17th issue of *The Lancet*.

Hot Scoop . . . The Milwaukee-based Johnston Company has done it again. Years ago it was the first commercial producer of fudge. Now, after two years of R&D, it has produced what many thought would be impossible: the microwave-able hot fudge sundae. Hot on the outside and cold on the inside, the "Hot Scoop" can go from the freezer to your lips in only 30 seconds. The sundae, available in chocolate, mint fudge and caramel, is being test-marketed in a few states and may soon be in a store near you. Can Baked Alaska be far behind?

PEOPLE

In October, Dr. Tom Rozzell will leave his post as manager of the Bioelectromagnetics Program at the Office of Naval

Research (ONR) to become the assistant director of the Associateship Program at the National Research Council-National Academy of Sciences. Starting 15 years ago with a budget of only \$50,000, Rozzell built the ONR program into a major source of funds for basic research — an area otherwise neglected by other federal agencies — and in 1978 he was instrumental in founding the Bioelectromagnetics Society. At the NAS-NRC, Rozzell will administer postdoctoral awards for young scientists in the life sciences at federal labs across the country. A search for his replacement at ONR is underway. . . Professor **Herbert Pohl** died of a heart attack on June 21 at the age of 70. Pohl taught in the Department of Physics at Oklahoma State University from 1964 to 1981 and was a visiting scientist at MIT at the time of his death. Pohl is best known for his research on the natural oscillating fields associated with living cells. He is the author of *Dielectrophoresis: The Behavior of Matter in Non-Uniform Electric Fields* (Cambridge University Press, 1978) and was the editor of the *Journal of Biological Physics*.

POWER LINES

No DC Risks in Minnesota . . . The majority on an expert advisory panel to the Minnesota Environmental Quality Board (MEQB) has reaffirmed its conclusion that a ± 400 kV DC power line poses no risk to public safety. Six members of the panel, which first declared the line safe in December 1982, found that none of the studies appearing in the literature in 1983 and 1984 contradicted their assessment (see *MWN*, January/February 1984). The lone dissenter, Dr. Robert Brambl of the University of Minnesota in Minneapolis-St. Paul, did not participate in the recent review, telling the MEQB that the new report supported his 1982 position " . . . that it is more likely than not that the line represents a potentially significant hazard to human and animal health." The majority opinion, presented in the MEQB's report, *Comments of the MEQB Science Advisors on Electrical Environment Outside the Right of Way of CUTR-1, Report 5*, is that "There still appears to be little likelihood that either chronic or acute exposure to small air ions and static electric fields at levels measured either on or downwind of the right of way of the DC line cause adverse health effects." The board issued *Report 5* in May 1985 as the final annual report in its five-year review of possible hazards from the Minnesota section of the Cooperative Power Association-United Power Association line, which also crosses part of North Dakota. In another report, the MEQB reported that its reanalysis of data on milk production, calving intervals and culling rates among cows living near the line supported an earlier analysis that found no significant effects. The report, *DHIA Bovine Performance and the DC Power Line*, includes more complex statistical analysis than the initial report presented, and it recommends against further study of cows. For more information, contact George Durfee of the Minnesota State Planning Agency, 100 Capitol Square Bldg., 550 Cedar St., St. Paul, MN 55101, (612) 296-2878.

STANDARDS

Power Line Noise . . . The International Special Committee on Radio Interference (CISPR) has released *Radio Inter-*

ference Characteristics of Overhead Power Lines and High Voltage Equipment. Part 3: Code of Practice for Minimizing the Generation of Radio Noise (Publication 18-3, 1986). The standard addresses (1) the design of power lines to control EMI to radio and television reception in the 150 kHz-300 MHz frequency range; (2) a method of predicting noise levels with a simple formula, and (3) ways of detecting and fixing loose and imperfect contacts that can spark and generate noise. It is available for \$37.00 (including postage and handling) from the American National Standards Institute (ANSI), 1430 Broadway, New York, NY 10018, (212) 354-3300. *Part 2: Methods of Measurement and Procedure for Determining Limits* is due out later this year. *Part 1: Description of Phenomena* was released in 1982 and can be purchased from ANSI for \$79.00, plus 7% for postage and handling. . . . The revised version of the ANSI-IEEE 1976 standard on *Procedures for the Measurement of Radio Noise from Overhead Power Lines and Substations* (ANSI/IEEE 430-1986) was approved for publication earlier this year and should be available from ANSI soon.

ETC. . .

Summer Reading. . . . Best-selling author and *New York Times* writer Jane Brody devoted her July 23 "Personal

Health" column to the safety of microwave ovens. Her first paragraph reflects the changing attitudes toward this best-selling appliance: "Ten years ago, when my husband wanted to give me a microwave oven for our anniversary, I asked him if he was trying to get rid of me. Last Christmas, however, I bought one myself." . . . Veteran *Aviation Week* reporter Philip Klass has written a fascinating history of electronic warfare — see "Radar Countermeasures" in the August issue of *High Technology*. . . . Jammers are finding a market among highway speeders, who want to confuse Smokey's radar gun. Such devices are illegal, expensive and, according to tests run by *Car and Driver* (April 1986), they don't work. The magazine recommends that those who want to go faster than 55 miles per hour should "stick with a reliable radar detector, a level head, quick reflexes and a keen pair of eyes." Certainly, sales of radar detectors continue to boom. According to an item in the July 7 *Time* magazine, 1.5 million people bought them last year, a 25% increase over 1984. A story in the August 1 *Wall Street Journal* quotes the president of Cincinnati Microwave, a leading manufacturer of radar detectors, as saying that most of his sales come on Mondays, after drivers have been nailed over the weekend. . . . COMSAT's J.V. Evans presents a review of "Twenty Years of International Satellite Communication" in the July/August issue of *Radio Science*.

Tumor Cells in ELF Fields (continued from p.1)

Phillips's tumor cell studies, carried out with equipment supplied by the New York State Power Line Project, have been the object of much speculation and controversy since preliminary data were disclosed two years ago by Dr. Wendell Winters, who set up the exposure system in his lab at the University of Texas Health Science Center in San Antonio (see *MWN*, April and September 1984).

A 1984 site visit report by New York state officials raised a number of concerns about how to interpret Winters's early statements (see *MWN*, November 1984). Some of those concerns persist today. Recently, Dr. Michael Shelanski of the New York University Medical School told *Microwave News*, "I don't think I can draw any conclusions, pro or con, about implications [of the studies] on the health effects of power line fields." Shelanski, who is the chairman of the New York project's Scientific Advisory Panel, questioned the large variations in the numbers of colonies among both the exposed and control cells — one of the major criticisms cited in the 1984 site visit report.

Phillips distanced himself from Winters's 1984 statements. Addressing the variability in colony formation, Phillips countered that unexposed (control) cells did not show that much variation. "Look at the published data," he said. The variation among the exposed cells is not all that surprising, he continued, because "we don't yet know why the cells are sensitive to EMF fields."

Proliferation and Immunity

In the first set of experiments, Phillips and coworkers exposed two lines of human colon tumor cells (Colo 205 and Colo 320 DM) to 60 Hz electric (300 mA/m²) and magnetic

(1.0 gauss) fields, singly and in combination, for 24 hours. Examination of the cells 7-14 days later revealed that the combined electric and magnetic fields and the magnetic field alone had significantly enhanced the number of tumor cell colonies. Also found were increased levels of tumor-associated antigens on the cells' surface. The cells exposed only to the electric field showed mixed effects.

Because the cells underwent a number of divisions over the course of the two-week experiment, the researchers suggest that the changes induced by the EMFs "are permanent and involve, therefore, an alteration of the cell's genetic information."

Next, in order to explain why the cells flourished in the field, the researchers studied how the same EMFs affected the number of transferrin receptors on their surface. Transferrin is a protein which transports iron and other metals through the cell membrane by binding to surface receptors; the number of receptors has been associated with cell proliferation.

Four, six and eight months after the same type of 24-hour exposure to the combined fields and to the magnetic field alone, cells had more transferrin receptors — approaching or exceeding the maximum possible number predicted by theoretical models. The ability of transferrin to bind with its receptor was unchanged. Those cells exposed only to the electric field, on the other hand, had fewer receptors than expected.

Here again, the exposed cell colonies multiplied prodigiously — up to a 24-fold increase relative to controls — and continued to do so eight months after exposure.

The normal regulatory systems had clearly stopped func-

tioning. Phillips's team again concluded that the EMFs had caused some basic and permanent change in the way the cells functioned.

In the third series of experiments, they examined the ability of human lymphocytes (natural killer cells) to destroy the EMF-exposed tumor cells, and they unexpectedly found that destruction of electromagnetic and magnetic field-exposed tumor cells "dramatically decreased."

Previous studies have indicated a relationship between the number of transferrin receptors and susceptibility to attack by lymphocytes, and so it is not clear why the cells with the largest number of receptors did not succumb to the lymphocytes. Nevertheless, their immunity enhances the general ability of the tumor cells to thrive after EMF exposure, further supporting the role of magnetic fields in cancer promotion.

Replication Underway

Dr. Maimon Cohen of the University of Maryland School

of Medicine in Baltimore has begun work on a replication study of these experiments under a grant from the New York State Power Line Project. The project had originally asked Dr. Gordon Livingston of the University of Utah in Salt Lake City to attempt the replication (see *MWN*, October 1984) but, according to Shelanski, that study did not work out.

References

Jerry L. Phillips, Wendell D. Winters and Loyce Rutledge, "In Vitro Exposure to Electromagnetic Fields: Changes in Tumor Cell Properties," *International Journal of Radiation Biology*, 49, pp.463-469, 1986.

Jerry L. Phillips, Loyce Rutledge and Wendell D. Winters, "Transferrin Binding to Two Human Colon Carcinoma Cell Lines: Characterization and Effect of 60 Hz Fields," *Cancer Research*, 46, pp.239-244, 1986.

Jerry L. Phillips, "Transferrin Receptors and Natural Killer Cell Lysis: A Study Using Colo 205 Cells Exposed to 60 Hz Electromagnetic Fields," *Immunology Letters* (in press). ●

Workers Claim Radar Accident (continued from p.1)

OSHA Could Not Substantiate Accident

A complaint was filed with the Occupational Safety and Health Administration (OSHA), but OSHA inspectors were unable to determine whether the radar had been turned on. William Masters, OSHA's area director for the state of Maine, said that no violation could be substantiated for radiation overexposure but a citation was issued for failure to post enough RF radiation hazard caution signs. During the same inspection, BIW was cited for not having a guardrail on one crane.

The citation for the lack of radiation signs does not entail a fine; the guardrail violation carries a \$640 penalty. BIW did not contest either citation and will pay the fine, according to an OSHA spokesman.

Dennis Brilliant, who was operating a crane and was at the same height as the radar, complains of lasting injuries and has not returned to work since the accident. Brilliant referred questions about his condition to his attorney, Jonathan Reitman of Brunswick, ME, who did not answer requests for comment.

A source familiar with Brilliant's condition told *Microwave News* that Brilliant is often disoriented and that his short-term memory is impaired. Brilliant has constant headaches and must take medication to dull the pain: "He is not the same man as he was before March 19," said the source, who requested anonymity. These symptoms are similar to those reported by the men involved in the radar accident at Clear Air Station in Alaska (see *MWN*, November 1983 and September/October 1985).

The Workers' Accounts

Notes written by two other crane operators describe how they felt at the time of the incident:

Joe Chagnon: "On March 19, 1986, around 7:10-7:15 [a.m.], I called my foreman and told him I was coming out of the

crane and going to first aid, because I had a headache. When I got to first aid, my head felt like it was going to blow up. The nurse said my face and neck were bright red. She checked me out and said my blood pressure was up and [I had a high pulse rate and a] fever. First aid told me to go to the hospital. . . The doctor also took pictures of my neck and right shoulder."

Paul Gosselin: "About 07:20, I experienced a tremendous headache and a burning sensation about my face, eyes and neck. I also felt weird all over. This seem[ed] to come in a matter of minutes. It also set off alarms in the drydock. At about 07:45, I went to first aid where elevated blood pressure was detected and also rapid pulse. . ."

BIW Report Due

BIW is preparing a report on the March 19 incident. Jim McGregor, BIW's director of public relations, told *Microwave News* that the report would be released on August 12 — although he had said previously that it would be available the first week of July. Asked about the delay, he said, "We want to make absolutely certain that the radar functioned properly and that whatever medical problems were reported were not caused by the radar."

A March 21 internal BIW memorandum obtained by *Microwave News* states that tests of the SPS-49 radar carried out that day produced "no discernible readings" on a "RADHAZ" meter.

Local 6's Mackie said that he remembers another accident a few years ago. But McGregor said that previous allegations of radar exposures had proved negative.

Dr. Jennifer Christian, an industrial hygienist at BIW, called many experts on the health effects of radar radiation after the accident, but she declined to be interviewed for this article.

The Navy did not respond to requests for comment. ●

CONFERENCES

Upcoming Meetings

September 8-11: **16th European Microwave Conference**, National Concert Hall, Dublin, Ireland. Contact: Microwave Exhibitions & Publishers, Convex House, 43 Dudley Rd., Tunbridge Wells, Kent TN1 1LE, U.K.

September 11-13: **Scientific Conference on Electropathology**, Physiologisches Institut der Universität Freiburg, Federal Republic of Germany (F.R.G.). Contact: Conference Secretariat, Forschungsselle für Elektropathologie, Reutebachgasse 11, D-7800 Freiburg, F.R.G., (0761) 56201.

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

September 14-19: **1986 IEEE/PES Transmission and Distribution Conference and Exposition**, Convention Center, Anaheim, CA. Contact: Charles White, South Carolina Electric and Gas Co., PO Box 764, Columbia, SC 29218, (803) 748-3518.

September 16-18: **IEEE International Symposium on Electromagnetic Compatibility**, Town and Country Hotel, San Diego, CA. Contact: George Ufen, GRU Associates, 1105 East Commonwealth Ave., Fullerton, CA 92631, (714) 738-0903.

September 17-19: **International Utility Symposium on the Health Effects of Electrical and Magnetic Fields: Research, Communication and Regulation**, Constellation Hotel, Toronto, Ontario, Canada. Contact: John O'Grady, Ontario Hydro, Suite H8 D4, 700 University Ave., Toronto, Ontario M5G 1X6, Canada, (416) 592-3395.

September 17-19: **1986 Symposium on Antenna Applications**, Allerton House, Monticello, IL. Contact: Paul E. Mayes, Dept. of Electrical and Computer Engineering, University of Illinois, 1406 W. Green St., Urbana, IL 61801, (217) 244-0543.

September 21-24: **3rd Congress of the European Society of Magnetic Resonance in Medicine and Biology**, University of Aberdeen, Scotland. Contact: Dr. Margaret A. Foster, Dept. of Biomedical Physics and Bioengineering, University of Aberdeen, Foresterhill, Aberdeen AB9 2ZD, Scotland, U.K., (0224) 681818, ext.3208.

September 22-25: **8th European Hyperthermic Oncology Scientific Meeting**, Rehovot-Tiberias, Israel. Contact: Dr. A. Yerushalmi, Dept. of Cell Biology, The Weizmann Institute of Science, Rehovot 76100, Israel.

September 23-25: **8th Annual Meeting and Symposium of the Antenna Measurement Techniques Association**, Westin Hotel,

Ottawa, Ontario, Canada. Contact: Laurier Forget, National Research Council, Ottawa, Ontario K1A 0R6, Canada, (613) 993-9009.

September 23-25: **8th Annual Electrical Overstress/Electrostatic Discharge Symposium**, Riviera Hotel, Las Vegas, NV. Contact: Michael Martin, 3M/Static Control Systems Div., 2111 W. Braker Lane, Bldg. 501, PO Box 2963, Austin, TX 78769, (512) 834-3117.

September 23-26: **Heating and Processing: 1-3000 MHz**, Cambridge, U.K. Contact: British National Committee for Electroheat, 30 Millbank, London SW1P 4RD, U.K.

September 29-October 3: **Montech'86: IEEE Week in Montreal**, Convention Center, Montreal, Quebec, Canada. Includes: Sept. 29-Oct. 2: **Conference on Antennas and Communications**, chaired by Dr. A. Kumar, (514) 457-2150; Sept. 29-Oct. 2: **Conference on HVDC Power Transmission**, chaired by Dr. P.C.S. Krishnayya, (514) 652-8342; Oct. 1-3: **Conference on AC Power Systems**, chaired by Gilles Baril, (514) 652-8212; Oct. 1-3: **Conference on Electrothermal Processes**, chaired by Edward Goodman, (514) 652-8546. General conference address: PO Box 37, Station "A," Montreal, Quebec H3C 1C5, Canada.

September 30-October 3: **5th International Conference and Tutorial Day on Electromagnetic Compatibility**, University of York, U.K. Contact: The Conference Secretariat, IERE, 99 Gower St., London WC1E 6AZ, U.K., (01) 388-3071.

October 6-7: **2nd International Conference on Harmonics in Power Systems**, Winnipeg, Manitoba, Canada. Contact: Robert Hamlin, Room 227, Engineering Bldg., University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada, (204) 261-4412.

October 6-12: **1st International School: Electromagnetic Fields and Biomembranes**, Pleven, Bulgaria. Contact: Professor Marko Markov, Dept. of Biophysics and Radiobiology, Sofia University, 8 Dragan Tzankov Blvd., Sofia 1000, Bulgaria.

October 14-16: **1st National Convention of the Society of Broadcast Engineers (SBE)**, A.J. Cervantes Convention Center, St. Louis, MO. Contact: SBE National Convention, PO Box 16861, St. Louis, MO 63105, (314) 725-2184.

October 19-22: **6th Annual Meeting of the Bioelectrical Repair and Growth Society (BRAGS)**, Utrecht, Holland. Contact: BRAGS, PO Box 64, Dresher, PA 19025, (215) 659-5180.

October 20-24: **11th IEEE International Conference on Infrared and Millimeter Waves**, Hotel Continental, Pisa, Italy. Contact: M. Inguscio, Dept. of Physics, University of Pisa, Piazza Torricelli 2, I-56100 Pisa, Italy, (050) 45222.

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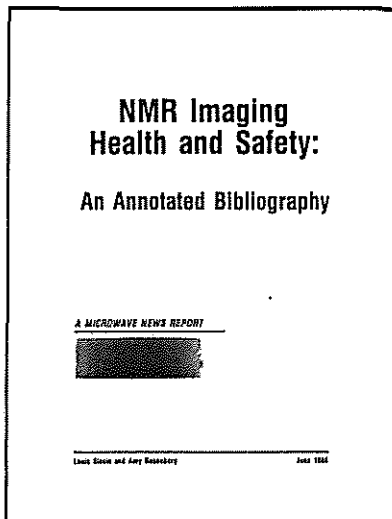
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