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Two Labs at Odds Over Microwaves and DNA Breaks Controversy Over Comet Assay

Three years after Drs. Henry Lai and N.P. Singh first announced that microwave radiation could increase the frequency of single-strand DNA breaks in the brains of live rats, their work is still clouded by controversy.

At scientific meetings over the last 18 months, Drs. Joseph Roti Roti and Robert Malyapa of Washington University in St. Louis have openly challenged the Lai-Singh findings, which are often cited as an indication of potential health risks from mobile phones.

Writing in the December 1997 issue of *Radiation Research*, Roti Roti and Malyapa report that 835 MHz, 847 MHz and 2450 MHz radiation did not increase the number of single-strand DNA breaks in two different types of cultured cells. They exposed the cells at specific absorption rates (SARs) of either 0.7 W/Kg or 1.9 W/Kg. Many analog cellular phones operate at 835 MHz, while a number of digital models operate at 847 MHz.

In another paper, accepted for publication by *Radiation Research* but not yet published, Roti Roti and Malyapa say that they have also failed to find any changes in the DNA in the brains of live rats exposed to microwave radiation.

Lai and Singh, both at the University of Washington, Seattle, contend that the Roti Roti-Malyapa work is flawed. "There is something seriously wrong with those experiments," Singh told *Microwave News*.

Not long after the Lai-Singh report of increased DNA damage became

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Long-Suppressed Draft EPA Report: EMFs Present a Cancer Risk

Power-frequency electromagnetic fields (EMFs) should be considered a risk factor for childhood cancer, staff at the Environmental Protection Agency (EPA) concluded in 1994. This conclusion appears in a report which was suppressed by EPA's senior managers and never released to the public.

The report, recently obtained by *Microwave News*, reveals that analysts at EPA's Office of Research and Development (ORD) recommended that: "[T]he apparently real association of disease with surrogates of prolonged magnetic field exposure has been established, so that it must be considered as one risk factor for [cancer]." (For the full text of the draft report's discussion and conclusions, see pp.7-8.)

Work on the report stopped in 1995 and it has been on hold ever since. "It is still an internal document and will probably not be released," said EPA's Dr. Robert McGaughy in early 1998. McGaughy, a senior scientist at ORD's National Center for Environmental Assessment in Washington, was in charge of

(continued on p.6)

« Power Line Talk »

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As the **RAPID** program draws to a close and the **NIEHS** focuses on finishing its final report to Congress, there comes word of another step in the review process. **Donna Shalala**, the secretary of Health and Human Services, will send the report on the EMF research program to Congress—not Dr. **Kenneth Olden**, the director of the NIEHS. Up to now, it has been generally assumed that Olden would decide how to answer Congress' mandate to determine whether EMFs affect human health. NIEHS staffers said that no one should be surprised by this extra layer of bureaucracy. "This is standard protocol," said Dr. **Gary Boorman**, who heads the RAPID effort at the NIEHS. According to NIEHS' present schedule, Olden's draft of the final report should be completed and sent to Shalala by October 30. Still unclear is how long Shalala will need to review—and possibly revise—the document before she forwards it to the appropriate congressional committees.

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Shirley Linde, the chair of the National EMF Advisory Committee, wants to make sure that the public is not misled by the way the **RAPID** final report is released. "The history of press releases from organizations of national stature asked to look into the status of EMF research leaves me with a chilling concern for what may come out of an NIEHS press release," she said at the opening of NIEHS' epidemiology review symposium on January 12 in San Antonio. Linde expressed her displeasure at the actions of the National Academy of Sciences, the National Cancer Institute and the *New England Journal of Medicine* and wants to make sure the same mistakes are not made again. Linde is asking that an advisory committee be set up to review the press materials accompanying the NIEHS report. Some in the audience were visibly irritated by Linde's blunt comments; others shared her concerns. For example, Dr. **Charles Poole**, an epidemiologist who recently joined the faculty at the University of North Carolina, Chapel Hill, expressed support for Linde's position. He believes that any effort to put a spin on a new paper or report is counterproductive because no one can predict how it will eventually play out. "At the time a paper is published, it is just embarking on its real peer review," he told *Microwave News*.

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At the beginning of the discussion of **childhood cancers** at the NIEHS epidemiology review, Dr. **David Savitz** of the University of North Carolina, Chapel Hill, asked those present if they believed that some aspect of EMFs is causally related to some form of childhood cancer. The 25-odd participants assigned a probability from 0 to 1, with 1 indicating certainty of a causal link. There was a wide variation in opinions—from 0 to 0.8, with a mean score of 0.55. Savitz repeated the exercise at the end of the session, after some hours of debate, and found that people had not changed their minds much. The mean rose just a tiny fraction, to 0.59. "Most people did not move at all," Savitz told *Microwave News*. "Either people were unresponsive to the arguments or they were already too familiar with them." Asked where he himself stood, Savitz replied, "After all these years, I am still on the fence."

The **California Public Utilities Commission (CPUC)**, not the civil courts, has sole jurisdiction over EMF personal injury claims, according to the December 8 ruling of an appeals court in San Francisco. This decision moved California one step closer to ending all EMF litigation in the state. The ruling in **Ford v. Pacific Gas & Electric (PG&E)** cited the state Supreme Court's **Covalt** decision, which had already granted the CPUC jurisdiction over EMF property cases (see *MWN*, M/J95, S/O96 and N/D96). On January 5, the appellate panel certified its opinion for publication, an important step because it establishes the opinion as precedent for California's lower courts. Asked about the effect on any new EMF personal injury cases, **PG&E** attorney **Frederick Baker**, of Sedgwick, Detert, Moran & Arnold in San Francisco, answered, "I think it effectively wipes them out." This decision is now binding on every Superior Court in the state." On January 16, **Cynthia Ford's** attorney, **Ron Herron** of Herron & Herron in San Francisco, asked the state Supreme Court to review the decision. Herron's petition contends that since the CPUC has no power to award damages, the *Ford* decision leaves anyone harmed by EMFs without a legal remedy. He told *Microwave News* that he expects a response within three months. Ford is the widow of a telephone line worker who died of a brain tumor in 1994 (see *MWN*, M/A95 and M/A97).

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Meanwhile, in New York, attorneys for **Howard** and **Eve Reiss** have petitioned the **U.S. Supreme Court** to hear an appeal in their EMF property lawsuit. They object to a New York court ruling dismissing their suit, which stated, "The EMFs at issue here are incapable of being perceived by the senses and, thus, are not capable of resulting in a 'physical' invasion." The Reisses' attorneys argue that to consider EMFs to be "nonphysical" only because they cannot be perceived by the five senses is a distinction that "makes no sense." They contend that the ruling violates the Fifth Amendment's guarantee against government "taking" of property without compensation. The Reisses filed suit in 1994 against **Consolidated Edison**, claiming that a Con Ed power line adjacent to their property caused them to lose 30% on the sale of their home in Pleasantville (see *MWN*, J/A94 and J/F97). In December 1996, an appeals court ruled against them, and in September 1997, New York's highest court refused to consider an appeal. **Eric Bregman** of Sive, Paget & Riesel in New York City, one of the Reisses' attorneys, said he expects the U.S. Supreme Court to say early this year whether it will take the case. **Joe Petta**, a spokesperson for Con Ed in New York City, told *Microwave News*, "We don't believe there is a constitutional is-

Correction

In the "Talk of San Diego," which appeared in our last issue (N/D97), we reported that Dr. David McCormick of the IIT Research Institute in Chicago did not attend this year's DOE-EPRI EMF review. In fact, McCormick was there and presented a poster paper. We regret the error.

sue here, and therefore the U.S. Supreme Court should not hear this case.”

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Dr. **Leonard Sagan** died of a brain tumor on December 8. Until his retirement in 1996, Sagan was a senior medical scientist at **EPRI** in Palo Alto, CA, where he worked on both ionizing radiation and EMFs. Sagan took over the institute's EMF program in 1986 in response to the electric utility industry's growing concerns over possible links between EMFs and cancer (see *MWN*, S/O86). By the time Sagan stepped down five years later, the EMF health studies program had a budget of \$10 million a year. In 1996, Sagan published a paperback book reviewing the EMF debate, titled *Electric and Magnetic Fields: Invisible Risks?*

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The **California EMF program** must still submit its final report by March 1, 2000. In December, the **CPUC** rejected a request for a ten-month extension from the state's Department of Health Services (DHS), which manages the EMF effort. At the same time, the commission gave the DHS permission to prepare a more ambitious report than the technical summary that was originally called for. The DHS will now produce an independent risk assessment that will be “an official [DHS] pronouncement on the hazard or safety of EMF exposure,” based not only on state-sponsored research but on all available evidence. **San Diego Gas & Electric** (SDG&E) had argued that the EMF program was not authorized to continue past December 1997, and asked the CPUC to shut it down by December 31, 1998 (see *MWN*, J/A97). But the CPUC recognized that the hiring of the program staff was not finished until 1995 and that research projects will not be completed until February 1999. The commission rejected SDG&E's deadline, but also refused to give the DHS more time to complete the newly expanded final report. That report must still be finished according to the original timetable, one year after the end of research.

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The utility industry may think that the question of power lines and cancer is closed, but the news has not yet reached the world of television. The issue was front and center in several recent episodes of **ABC's** courtroom drama series *The Practice*. A group of cancer patients are shown suing “Boston Power,” whose transmission line runs near their homes, and the state of Massachusetts. They claim that the power line caused their cancers and that the state failed to warn them of the EMF hazard. Their only expert witness is a former Boston University epidemiologist, whose career took a nosedive when he attempted to go public with his research linking power lines and cancer. He then became an alcoholic. On the EMF-cancer link, he argues that, “Just because we have not figured out why does not mean we don't have a problem.” The plot touches all the bases: The plaintiffs' attorney seeks to introduce “two recent Swedish studies” showing that children living near power lines are more likely to develop leukemia, as well as the EPA draft cancer report (see p.1). To buttress its defense, the utility puts 11 experts on the stand, including a Yale professor who at first says he knows of no evidence to support the plaintiffs' claims but later softens that position under

Watson & Renner Firm Splits

There has been a split in the law firm of Watson & Renner, which has represented many utilities in EMF cases. The firm's Denver and Washington offices have separated, and informed sources say that litigation may follow.

Watson & Renner's Denver office opened in mid-1997, with attorneys who had worked on EMF suits in the Denver office of LeBoeuf, Lamb (see *MWN*, M/J97). Now the Denver office has closed, and attorneys there have opened a new firm.

“Watson & Renner, PLLC, agreed that the firm would no longer do business effective January 1,” Denver attorney Mark Warnquist said in an interview. “Thereafter, the Washington and Denver offices set up new firms. We have a new firm here, Yates & Leal, with five lawyers, four of whom are partners.” Warnquist would not comment on the reasons for the split.

“It's not a big deal,” said Tom Watson, downplaying the seriousness of the dispute. “In my mind it's an accounting matter. Of course, you have the usual lawyer-posturing, but ultimately I think it'll get settled.”

A source close to the conflict said that it was touched off when the Rittman family dropped its cellular phone lawsuit (see *MWN*, N/D97), in which Watson & Renner was representing defendant Cellular One. According to this source, a disagreement over who would handle the firm's remaining EMF work led to its breakup, the closing of the Denver office and the layoff of all support staff in Washington.

Watson denied these assertions: “Our clients, of course, were pleased to put an end to the Rittman suit without the expense of a trial. And as far as we're concerned, that just brings in more business for the future.” The Rittman case had no relation to changes in the firm, he insisted, and it sparked no changes in staffing in Washington. “We've always been a very lean-staffed outfit. If you can use a computer and do your own voice mail, you don't need a secretary.” Nor did the DC office have to lay off any legal assistants, he said, because “the Rittman case hadn't kicked into high gear yet.”

Watson admitted that the legal entity of “Watson & Renner, PLLC,” no longer exists. But, he said, “we're still here, doing the same things for the same people.” The three lawyers in the Washington office are now doing business simply as “Watson & Renner,” he explained, “the name under which we began a few years ago.”

cross-examination. Other details seem to have been borrowed from the lawsuit filed by famed Texas litigator Joe Jamail on behalf of 11 families whose children have cancer and from a childhood leukemia lawsuit settled out of court by Massachusetts Electric (see *MWN*, M/A95, J/A95 and S/O95). After the television plaintiffs reject first a \$1 million and then a \$6 million settlement offer, the jury awards them \$3 million in damages from the utility and \$36 million from the state. But there is no happy ending for the plaintiffs. The presiding judge overturns the jury's verdict—on a motion from Boston Power—because the cancer connection, he contends, was based on invalid science. The plaintiffs vow to appeal.

New Animal Studies Find No Link Between 50/60 Hz Magnetic Fields and Cancer

Three new animal experiments have found no evidence that EMF exposure increases the risk of cancer. The studies include large-scale, two-year efforts in Canada and in Japan, and a smaller, eight-week experiment in the U.S.

"These studies represent additional information," said Dr. Gary Boorman of the National Institute of Environmental Health Sciences (NIEHS) in Research Triangle Park, NC, an expert in animal toxicology and head of the EMF RAPID research program. "But it's the cumulative evidence that matters."

In an interview, Boorman declined to comment on the weight of that evidence so far, explaining that whatever he said would soon be obsolete. This April, he said, the NIEHS will hold a science review symposium on EMF animal research which "should have eight or nine studies to discuss, five or six of which will have completely new data."

All three new studies exposed F344 rats to continuous power-frequency magnetic fields for about 20 hours a day. Researchers took great pains to ensure, as the Japanese team put it, that "the fields were not contaminated by transient spikes" or harmonics. The Canadian group, led by Dr. Rosemonde Mandeville of the University of Quebec in Laval, explained that its goal "was to evaluate the carcinogenicity of 60 Hz magnetic fields *per se*."

Mandeville exposed four groups of 50 female rats each to fields of 20 mG, 200 mG, 2 G or 20 G. In her paper, she explains that the induced currents in rodents are 10-15 times smaller than in humans: "Accordingly, the lowest field intensity [20 mG] gives rodents an exposure that may be slightly higher than residential exposures for humans."

In this experiment, the overall incidence of tumors was actually lower in the exposed groups than among controls, though this difference was not statistically significant. Mandeville paid particular attention to leukemia and to brain and breast tumors. No significant dose-response trends were found for specific tumors, except for pituitary gland adenoma, which showed an inverse relationship with EMF exposure. Mandeville believes this association is probably due to chance.

Mandeville calculates that the number of animals used gives this experiment the power to detect a doubling of the risk of cancer. Smaller increases, however, could go unnoticed.

The study was funded by the Canadian health ministry, the government of Quebec, Hydro Quebec and Ontario Hydro.

The Japanese team, led by Mitsuru Yasui of the Tokyo Electric Power Co.'s Engineering Development Center and Dr. Yoshihisa Otake of the Mitsubishi Kasei Institute of Toxicological and Environmental Sciences in Ibaraki, used three groups of 48 male and female rats. Two groups were exposed to 50 Hz fields, at strengths of 5 G or 50 G, while the third served as the control.

There was a statistically significant increase in one benign type of skin cancer among male rats, with nine cases in the 50 G exposure group as compared to two among controls. There were also five cases in the 5 G exposure group. The researchers write that the incidence in the 50 G group "is insignificant compared with historical control values in our laboratory," and "therefore

can be considered as a chance occurrence."

The U.S. study was part of NIEHS' National Toxicology Program (NTP), and was carried out in an exposure facility at the IIT Research Institute (IITRI) in Chicago directed by Dr. David McCormick, with Boorman's collaboration (see *MWN*, S/O90 and S/O92). In addition to F344 rats, B6C3F1 mice were also used, with 10 male and 10 female animals in each exposure group. Exposure levels for both rats and mice were 20 mG, 2 G or 10 G. Overall, the researchers found "no evidence of toxicity related to eight-week exposure to 60 Hz magnetic fields."

In addition to the three continuous exposures, one group of rats and another of mice were exposed to intermittent fields of 10 G, switched on or off every hour. No EMF effects were observed in these animals, either.

The results of a two-year NTP study, conducted at IITRI with 2,000 animals and the same exposure levels, will be released in time for the NIEHS symposium in April, Boorman said.

Many of the animal studies linking cancer and EMF exposure have been initiation/promotion studies, including those by Drs. Craig Byus and Maria Stuchly (see *MWN*, M/A96 and M/A97), Dr. Jukka Juutilainen (see *MWN*, M/A96) and Dr. Wolfgang Lüscher (see below). In this type of experiment, animals are exposed to a known carcinogen and then to EMFs, to see if EMFs promote the growth of the resulting cancers.

None of the three just-published studies used this design, but Boorman believes they are relevant to an evaluation of whether EMFs promote the development of cancer. "Promoters still in-

No EMF–Breast Cancer Link Seen in Lüscher Replication

In their attempt to repeat key German animal experiments, U.S. researchers did not find that EMFs promote breast cancer. Drs. Larry Anderson and James Morris of the Battelle Labs in Richland, WA, sought to replicate the breast cancer effect under a contract from the NIEHS, as part of the RAPID research program (see *MWN*, M/A96 and M/A97).

"Preliminary reports suggest that Anderson's team has been unable to repeat the German findings," according to NIEHS' Dr. Gary Boorman.

Anderson and Morris tested whether EMFs would promote the development of breast cancer initiated in female rats with the chemical carcinogen DMBA, as first reported by Drs. Wolfgang Lüscher and Meike Mevissen of the School of Veterinary Medicine in Hannover, Germany (see *MWN*, J/A93, J/F95, M/A95 and J/A95).

Boorman told *Microwave News* that a technical report on the Battelle work will go through a public peer review on March 11 at the NIEHS in Research Triangle Park, NC. The peer-review panel will include Dr. Martin Misakian of the National Institute of Standards and Technology in Gaithersburg, MD, and Dr. Maria Stuchly of the University of Victoria in British Columbia, Canada.

crease cancer in most long-term studies,” he explained. “The idea is that the animals contain already-initiated cells. So, although I’ve heard some concern that a promotional effect may not be seen without an added initiator, this is not necessarily the case.”

The NIEHS science review, to be held April 6-9 in Phoenix, will consider new data from initiation/promotion studies on breast cancer carried out at the Battelle Pacific Northwest Labs (see box on p.4), and at Sweden’s National Institute of Occupational Health by Dr. Tomas Ekström, as well as from a 2,600-mouse study of leukemia at the University of California, Los Angeles sponsored by the Electric Power Research Institute (EPRI).

Brain cancer is rare in humans, and was rare in the animals in the recent Mandeville, Yasui-Otaka and Boorman-McCormick studies. Boorman noted that this means larger numbers are needed to detect an effect, if any. A UCLA brain tumor study with over 3,000 mice should also be finished by April, he added.

Mandeville is currently finishing an initiation/promotion study of brain cancer, with the same EMF exposures as her study described above. She said, “We are working very hard to get that done in time to present results” at the NIEHS symposium.

Hopefully, said Boorman, a clearer picture will emerge from that meeting. But he cautioned that, “Sometimes the public and others expect a simple yes-or-no answer, when the problem is more complicated than that.” Mandeville commented, “It’s going to be very exciting to be at that meeting and see what happens. We’ll have results from something like 15,000 animals. D-Day is really the April symposium.”

“I believe there are biological effects of magnetic fields,”

Mandeville said in a November interview. Her lab found effects on ODC, an enzyme involved in tumor promotion, after as little as five weeks of exposure. She said that ODC effects have been “demonstrated and repeated” at EMF levels as low as 20-40 mG (see *MWN*, N/D97).

However, Mandeville suggested that the development of cancer may be too complex for the effects of EMFs to emerge clearly in laboratory studies. “I think we are looking at the wrong thing,” she explained, adding that she would like to study neurological effects of EMFs, such as their possible impact on Alzheimer’s disease (see *MWN*, J/F97).

Among current animal studies, Boorman said that only Ekström has examined the effects of transients, and he knows of no recent or ongoing studies of cancer and EMF harmonics.

He also knows of no animal studies with circularly polarized fields, as opposed to the linear fields in the three just-published studies. “We debated whether to use those as well,” he explained, “but at the outset there was no reason to think that would make a difference, and the engineering requirements are more complex. Right now I’d say it would be nice to have had that as well.”

G. Boorman et al., “Eight-Week Toxicity Study of 60 Hz Magnetic Fields in F344 Rats and B6C3F1 Mice,” *Fundamental and Applied Toxicology*, 35, pp.55-63, 1997.

R. Mandeville et al., “Effects of the Potential Carcinogenicity of 60 Hz Linear Sinusoidal Continuous-Wave Magnetic Fields in Fischer F344 Rats,” *The FASEB Journal*, 11, pp.1,127-1,136, November 1997.

M. Yasui et al., “Carcinogenicity Test of 50 Hz Sinusoidal Magnetic Fields in Rats,” *Bioelectromagnetics*, 18, pp.531-540, 1997.

Yale Study Links Miscarriage And Electric Blanket Use

Use of electric blankets at the time of conception almost doubles the risk of spontaneous abortion, according to Dr. Kathleen Belanger and colleagues at Yale University in New Haven, CT.

Their prospective study, published in the January 1998 issue of *Epidemiology* (9, pp.36-42), followed 2,967 women who planned to give birth at Yale-New Haven Hospital between 1988 and 1991. No increased risk was found for use of electrically heated waterbeds, or for living near high-current power lines.

The women were originally interviewed before their 17th week of pregnancy; 135 of them had a miscarriage in the succeeding months. Those using electric blankets during the month they became pregnant were 1.84 times more likely to have a spontaneous abortion than those who did not, a statistically significant increase. When this figure is adjusted for such factors as age and caffeine consumption, the relative risk falls to 1.74 and is not quite significant.

Among daily users of electric blankets, the risk to pregnancy was higher with longer use, as well as with higher temperature settings. But these results were far from significant, and the Yale team notes that they are based on small numbers.

A limitation of this study, according to Belanger and coworkers, was its inability to detect early pregnancy loss: “Only 14.1% of the cohort was interviewed before 10 weeks’ gestation, but the greatest proportion of pregnancy losses occur before the tenth

week of pregnancy, often before pregnancy is even recognized.”

The paper notes that a Finnish study of residential EMF exposures overcame this problem by following women who were attempting to have a child and testing for changes that occur in the body at the beginning of pregnancy. Dr. Jukka Juutilainen of the University of Kuopio found that those with higher exposures had more than five times the risk of pregnancy loss compared to women who were less exposed (see *MWN*, M/A92).

“The Juutilainen study suggests that the loss happens very early,” commented Dr. Nancy Wertheimer from Boulder, CO. “I would expect to see the effect only in the very early spontaneous abortions, and the Yale study missed most of those.” On the finding of a link to miscarriages later in pregnancy, Wertheimer said, “We’ll have to see how that fits in with other data.”

To evaluate the effects of residential EMFs from power lines, Belanger used the wire code categories first developed by Wertheimer and Ed Leeper for their study in Denver. “It’s not clear that our wire codes work very well in the New Haven area,” Wertheimer told *Microwave News*. “In any case, my intuitive impression is that power line fields will rarely be high enough to have an impact” on spontaneous abortion rates, in contrast with the much-higher exposures caused by using electric blankets.

Belanger did not respond to repeated requests for comment. Her study was supported by EPRI and the National Institute of Drug Abuse. It drew on a data set previously used by Dr. Michael Bracken, Belanger and others at Yale in a study of EMF exposure and electric blanket and waterbed use, which found no link to birth defects or low birth weight (see *MWN*, M/J95).

writing the report.

Over the last three years, the EPA has repeatedly refused to release the report. For instance, when Curt Suplee, the science editor at the *Washington Post*, filed a Freedom of Information Act request for the report a couple of years ago, the agency declined to give it to him, arguing that the document was still under review and therefore not subject to the act.

The first draft of the EPA report, completed in early 1990, recommended that EMFs be classified as “probable human carcinogens,” a designation previously given to DDT, PCBs and formaldehyde. When that draft was released to the public later that year, this designation was deleted, but the EPA nevertheless concluded that EMF studies of leukemia, lymphoma and brain tumors among children and workers “show a consistent pattern of response that suggests, but does not prove, a causal link” (see *MWN*, M/J90 and N/D90).

The 1994 report found that the evidence of an EMF–cancer link had become stronger over the next four years. “On the whole,” it concluded, “the epidemiologic evidence with respect to childhood cancer and EMF exposure more clearly points to an increased risk of cancer, especially leukemia, in relation to residence in homes with exposures determined by high wire code configurations, close proximity or historically calculated fields.” During the time between the completion of the two drafts, Drs. Maria Feychting and Anders Ahlbom of the Karolinska Institute in Stockholm, Sweden, announced that they had found a reliable association between childhood leukemia and historically calculated EMF exposures (see *MWN*, S/O92).

The EPA conceded, however, that there was much still to be learned. Uncertainties remain, the 1994 draft continued, “on the nature of the relevant exposure parameters,” and these “still render the data insufficient to conclusively determine a causal relationship with field parameters that are measurable.” The report also cautioned that there was “little evidence” of an association between residential EMF exposure among adults and cancer.

In interviews with *Microwave News* this January, both McGaughy and Dr. Doreen Hill, who drafted the epidemiology chapter of the EPA report, noted that the conclusions of their report were consistent with those in the chapter on EMF epidemiology in the report issued by the National Academy of Sciences–National Research Council (NAS–NRC) (see *MWN*, S/O96).

“They are not that different,” McGaughy said. “The conclusions are similar,” added Hill, who commented that, “Politics always overshadow everything.” Hill, who used to work at the EPA in Washington, is now with Energetics Inc., a consulting firm based in Columbia, MD.

Dr. Christopher Portier of the National Institute of Environmental Health Sciences (NIEHS) in Research Triangle Park, NC, who is leading the EMF risk assessment for the RAPID program, agreed with McGaughy and Hill that the NAS–NRC and EPA reports are in many ways quite similar. McGaughy has provided the NIEHS with a copy of the EPA report, though the EPA stipulated that the NIEHS could not cite it or quote from it.

McGaughy, Hill and Portier’s comments will surprise many, since there is a widespread impression that the EPA and the NAS–NRC reports are at odds with each other. In an interview with *Microwave News*, Portier resolved the apparent contradiction.

“They had very different objectives,” he explained. The NAS–NRC sought a yes-or-no answer to the question of whether a causal link between EMFs and cancer has been proven, Portier continued, while the EPA was addressing the issue from a public health perspective.

“The NAS–NRC wanted conclusive proof, but sometimes the issues are not black and white,” McGaughy said. “In such cases, we must be sure that our actions are based on a reasonable probability of harm. This appeared to be the case for EMFs.”

The conclusions of the draft 1994 EPA report are also in general agreement with those of the EMF report drafted by a committee of the National Council on Radiation Protection and Measurements (NCRP) (see *MWN*, J/A95). That report called for strong action to curtail EMF exposures of the U.S. population. Although it was forwarded to the NCRP in 1995, that report is still under review by the council and has not been officially released.

The 1990 EPA report caused an international sensation and prompted strong criticism from the electric utility industry (see *MWN*, J/F91). The following year, a review by EPA’s Science Advisory Board downplayed the cancer risk and asked that the report be revised (see *MWN*, M/J91 and J/A91).

After McGaughy completed the new draft of the EMF report in August 1994, he sent it out for peer review by four scientists from outside the agency. At that time, McGaughy asked that those receiving a copy of the report not reveal or distribute any section of it, at least in part because “the conclusions are not yet fully developed.”

McGaughy completed a revised draft of the cancer report in September 1995. The next step was slated to be a review by other federal agencies, but instead the report was shelved (see *MWN*, J/F96).

The 1995 draft is “not materially different” from the 1994 draft, McGaughy said, but “the argument is more solid and some mistakes were corrected.” McGaughy declined to provide a copy of the 1995 draft to *Microwave News*.

When asked whether last year’s epidemiological study of childhood leukemia and EMFs by the National Cancer Institute (see *MWN*, J/A97) would have changed his conclusions, McGaughy replied “This one study is not enough to overcome past studies.”

The EPA has said that the decision to stop work was largely due to budget constraints, but a number of agency staffers now place the responsibility for abandoning the EMF effort on senior managers at EPA’s ORD as well as on Ramona Trovato, then the director of the Office of Radiation and Indoor Air. None of the senior managers wanted to revisit the controversial subject of EMFs, agency sources said.

In addition, industry pressured the agency not to release the cancer report. Leading this movement was Douglas Bannerman of the National Electrical Manufacturers Association in Washington. In 1995, Bannerman argued that, “We should not have individual agencies popping up and giving their own risk assessments” (see *MWN*, M/A95). Later that same year, the U.S. Senate Committee on Appropriations cut \$350,000 out of the EPA budget because “the committee believes EPA should not engage in EMF activities” (see *MWN*, S/O95). Soon afterwards, the EPA stopped all work on the cancer report.

Draft EPA Cancer Report: Discussion and Conclusions

Note: This chapter presents the main conclusions, but is not yet polished, precise, or comprehensive enough to be considered even the authors' final position, and of course EPA review is needed before it can be considered the EPA position. The authors invite comments on this draft.

DISCUSSION AND CONCLUSIONS

Residential Studies

The childhood cancer epidemiology studies consistently show repeated findings of a small excess relative risk of leukemia and brain cancer in children who live in homes near the electrical power distribution network. In this statement, "small" means an odds ratio of 1.5 to 3.5 with lower 95% confidence bounds close to 1.0 in individual studies and above 1.0 when studies are combined using meta-analysis techniques by expert groups of epidemiologists. In this statement, "near" means either (a) in the U.S., homes with a wire code classification of VHCC, which is the highest magnetic field exposure category of weighted distances from distribution lines, or (b) in Scandinavian countries, which classify homes using calculated historical average bedroom fields based on transmission line current loading, "near" means historical average values over 0.2-0.3 μT (2-3 mG).

Both of these measures of proximity to power lines are surrogate measures of prolonged magnetic field exposures, and they combine information about distance to the line along with information about the line configuration and current loading. The distances of VHCC homes from representative distribution lines in the U.S. studies are less than about 40-60 feet, whereas the residential distance from the transmission lines in the Swedish studies is within about 50 meters. VHCC homes in the U.S. typically have bedroom magnetic fields higher than 0.2-0.3 μT (2-3 mG), as discussed in Chapter 2. No confounding exposures to other agents or factors that co-vary with these surrogates and that are known causes of these cancers could be identified, despite efforts to evaluate the most obvious factors. Until such factors are identified, the interim conclusion is that these surrogates of prolonged magnetic field exposure are a causative factor.

Two aspects of this interim conclusion need discussion: (a) the confidence that the association is real as opposed to being biased by improper epidemiologic methods and (b) what measurable magnetic field parameters correspond to the surrogate measures of prolonged exposure.

Before the Scandinavian studies were published in 1993, the results of the major studies that appeared to support the original observations of Wertheimer and Leeper, namely Savitz et al. (1988) and London et al. (1992), could be explained by the hypothesis that the positive associations might have been created by a biased selection of control populations, which were selected by random digit dialing. Since the Scandinavian studies did not have these potential biases and still showed results consistent with earlier findings, the overall opinion of several expert review panels is that there is a real association that cannot be explained away by improper epidemiologic methodology.

One difficulty in accepting the interim conclusion that prolonged magnetic field exposure (or its surrogates) is a causative factor is the consistent finding that the actual spot measurements of fields in some studies and 24-hour measurements in the London et al. (1992) study, which were made after the diagnosis, do not correlate at all or correlate only weakly with the disease. However, this difficulty becomes less serious when one realizes that the number of home measurements is typically smaller than the number of homes for which wire codes were available. This leads to a lower statistical power to detect population differences in measured fields.

Apart from the statistics of determining the magnitude of the fields, the interpretation of these data is complicated by the large time span of several years between the time the disease was presumably developing

and the time of the measurement, which was after the diagnosis. To infer that the postdiagnosis data are relevant, one must be willing to assume that spot or 24-hour average measurements are well correlated with yearly average fields across several years and that spot measurements made during the day are well correlated with the 24-hour averages. Although the electrical current loading of the lines is known to vary systematically on a daily and seasonal basis, making an extrapolation back over several years is problematical.

In spite of these difficulties in accepting the measurement data as valid and interpreting them, as discussed above, one could nevertheless explore the consequences of accepting the hypothesis that measured fields have nothing to do with the disease, whereas prolonged field exposure does affect the disease. Then the attention is focused on the question of what parameters of the field are causing the effects and why the measurements do not reflect these parameters.

There are four different proposed classes of mechanisms of field-tissue interactions, each with some experimental support and each requiring different exposure conditions: (a) A coherent alternating field must be present for times on the order of 10 seconds or longer to be effective (Litovitz); (b) Fast transient fields with a time constant on the order of 25 milliseconds or less are required (Lerchl); (c) Prolonged exposure to narrowly defined intensity ranges of combinations of time-varying and static magnetic fields is necessary (Blackman and Blanchard); and (d) Exposure at night and not in the daytime is required to affect the nocturnal synthesis of melatonin (extension of Reiter's ideas). Of these four exposure mechanisms, only the first is actually measured by the spot or 24-hour average measurements, and it is also reflected in the surrogate measures of prolonged average field exposure. Therefore, if this were the predominant mechanism of disease, both measurements and surrogates for the average field should correlate with the disease. This is not the case, so either that mechanism is not operating or the hypothesis is wrong. If any of the other three mechanisms were operable, then the spot and 24-hour average measurements would not measure the relevant parameters, but the prolonged average would still correlate with the disease, since it decreases as one moves away from the source. In summary, all four of the potential metrics should correlate with the surrogates for prolonged exposure, and the last three mechanisms are not even components of the measurements. Therefore, the last three mechanisms are fully compatible with the observations, and the first mechanism might or might not be compatible with the observations.

One by-product of this line of reasoning is that all of the proposed mechanisms correlate with the prolonged field exposure surrogates, so a reduction of the average field will reduce the risk regardless of which mechanism or combination of mechanisms should eventually prove to be correct. If it is not practical to move away from the source, the different mechanisms require different exposure reduction strategies. Another difficulty in accepting the interim conclusion that prolonged magnetic field exposure is a causative factor is the fact that average fields of 0.2-0.3 μT (2-3 mG) induce extremely small electric fields and currents in body tissue, as explained in Chapter 6. These induced electric fields are smaller in magnitude than electric fields produced by thermal noise in single cells and by endogenous activity of the nervous system. However, the induced fields have a different spatial and temporal pattern on the single-cell level, and current theories are investigating how cells and/or tissues could detect these small fields and distinguish them from endogenous fields. These theories are just being formulated and have not been experimentally verified.

Regardless of which exposure metric explanation may eventually be accepted, the apparently real association of disease with surrogates of prolonged magnetic field exposure has been established, so that it

must be considered as one risk factor for the disease. An explanation of the physical nature of this risk factor cannot be established with epidemiologic studies alone.

Occupational Studies

A large number of occupational studies have shown excess risk of leukemia and central nervous system cancers in people occupationally exposed to electromagnetic fields. A smaller number of studies have shown lymphatic cancers and breast cancer in males. The early studies were associations based on job titles, but they have been confirmed in some but not all of the recent studies where identification of exposed people has been based on field measurements at the job site. The characteristic findings are similar to the childhood cancers in that the relative risks seldom exceed 3.0 (with the exception of male breast cancer, where the relative risk is 6 in one study). A recent study of electrical workers reported an exposure-dependent risk coefficient expressed as relative risk per 1 μ T (10 mG) field exposure. This is the first report of a quantitative relation between relative risk and an exposure parameter.

Although childhood and adult cancers are different diseases, they are related closely enough that their occurrence in adult occupational settings lends support to the magnetic field causality postulate derived from childhood residential power line studies.

Breast Cancer

In many respects there is a more complete set of data indicating a

risk of breast cancer in male workers than for residential childhood cancer, although the dimensions of the potential hazard are still far from clear. There are three case-control studies showing excess risk of male breast cancer in workers, two of which have relative risks ranging from 2.0-6.0. There are two rat studies of long-term exposure (90 days and 2 years) to 50 Hz magnetic fields subsequent to the initiation of tumors by chemicals. These studies show an increase in mammary carcinoma incidence, size, malignancy, and growth rate. There is a third, 90-day rat promotion study with 50 Hz, 1.0 μ T (10 mG) fields showing a reduction of serum melatonin and, in the same animal group, a small, nonsignificant increase in mammary gland hyperplasia, indicating that even at this low flux density the tissue is being affected. This *in vivo* indication of possible carcinogenic activity has a plausible mechanism in the relatively well-established growth inhibition capability of melatonin in laboratory animals and in breast cancer cells in culture. An extremely large uncertainty in the validity of this mechanism in humans is the poorly understood relation between magnetic field exposure and the reduction of melatonin concentrations, especially in humans but also in experimental animals. There is a clear need for research to clarify these issues. This need is underscored by the recent, very preliminary results of Loomis and Savitz showing a slight excess of female breast cancer in electrical workers, a result that is too weak to establish a connection with female breast cancer but which is consistent with a hypothesis of causality.

HIGHLIGHTS

« Wireless Notes »

Another member of the bioelectromagnetics community is joining **Motorola** to work on product safety. On April 20, Dr. **C.K. Chou** will become the director of its corporate RF Dosimetry Lab in Plantation, FL. Norman Sandler, a company spokesperson, said that the addition of Chou is a "further enhancement of Motorola's widely recognized expertise in an area that is increasingly important to product testing and to RF biological research." Working at the City of Hope National Medical Center in Duarte, CA, over the last few years, Chou has developed a head-only exposure system for cellular phone radiation animal studies under a contract from **WTR** (see *MWN*, M/J95). This spring, Drs. **Henry Lai** and **N.P. Singh**, both of the University of Washington, Seattle, and Dr. **Ray Tice** of Integrated Laboratory Systems in Research Triangle Park, NC, are scheduled to go to Chou's lab at the City of Hope to repeat the Lai-Singh experiment on DNA breaks in the brains of rats (see p.1 and *MWN*, N/D97). (At press time, however, WTR had still not yet signed the contracts for this work.) Chou stressed that although he will be leaving California, he will see these experiments through until completion. "I will make sure the biology is all done," Chou told *Microwave News*, adding that doing so may require a bit of back-and-forth from Florida. Before moving to the City of Hope, Chou worked at the Bioelectromagnetics Research Lab at the University of Washington, Seattle, where he collaborated with Lai and Dr. **Bill Guy**, who became one of the three directors of WTR after his retirement from the university. As the cellular phone radiation issue has grown, Motorola has added more senior staff to work on safety issues, including Dr. **Mays Swicord**, formerly of the U.S. FDA and Dr. **Ken Joynner**, formerly of Aus-

tralia's Telstra (see *MWN*, J/A95 and J/F97). Motorola also has a committee of five science advisors, who, according to Sandler, "advise Motorola on the direction and conduct of its research related, for the most part, to product safety." The science advisors include Dr. **Charles Stevens** of the Salk Institute in La Jolla, CA, who headed the NAS-NRC committee on the health effects of EMFs (see *MWN*, N/D96). The other members of the committee are: Dr. **Patricia Buffler**, University of California, Berkeley; Dr. **Marvin Goldman**, University of California, Davis (emeritus); Dr. **Roland Schmitt**, president emeritus, Rensselaer Polytechnic Institute, Troy, NY; and Dr. **Robert Weinberg**, MIT, Cambridge, MA.

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Like other countries, the Republic of **Ireland** has seen waves of local resistance to mobile phone towers. Last November 17, for instance, the *Irish Independent* quoted an irate resident of Carrickon-Shannon, a site of planned **Esat Digifone** and **Eircell** transmitters, who wondered, "How can the government stand over the siting of these masts in a residential area with children playing nearby? It seems it has facilitated big business over us." And some of the public concerns have won some sympathy. For instance, *The Examiner*, a newspaper in Cork, ran an editorial on January 29, titled **PHONE MASTS RAISE GENUINE HEALTH FEARS**. Now, three departments of the Irish government are sponsoring a conference on possible health effects of radiation from wireless base stations, to be held in Dublin on March 6. The conference will "address the issues in an open and comprehensive manner" and "provide an open forum for debate," according to

the brochure. Among those who will be flown in are Drs. **Alastair McKinlay** of the U.K.'s NRPB, **Russell Owen** of the U.S. FDA, **Michael Repacholi**, head of the WHO EMF Project in Geneva, Switzerland, and **Thomas Tenforde** of Battelle PNL in Richland, WA. While the conference is primarily for "local authorities and health boards," it is also open to the public for a fee of approximately \$105. Industry representatives must pay \$490. For more information on the conference, *Communications Technology in the Community*, contact: Mary Bruton, Institute of Public Administration, 57-61 Lansdowne Rd., Dublin 4, Ireland, (353+1) 668-6233, Fax: (353+1) 668-9135, E-mail: <mbruton@ipa.ie>.

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Mobile-phone **base stations** "do not constitute any risk regarding radiation protection." So concludes the **Swedish Radiation Protection Institute**, known as SSI, in a flyer distributed with its December 1997 newsletter, *SSI News*. SSI radiation surveys indicate that approximately 10 meters from an antenna "the radiation intensity is very low." SSI notes that, "When an antenna is placed in a high position, the maximum radiation intensity at the ground level may be less than a tenth of the permitted level. In many cases when the general public has shown concern, radiation intensity has proved to be less than a thousandth of the permitted level." Under Swedish health standards, the general population can be exposed to up to 450 $\mu\text{W}/\text{cm}^2$. SSI does caution that, "The permitted levels are exceeded within a distance

of one meter directly in front of the antenna's radiating surface." The full text of SSI's advice on base stations is on its Web site: <www.ssi.se/english/index.html>. For more information, fax SSI in Stockholm at (46+8) 729-7108.

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In the January 5 *Medical Journal of Australia* (168, p.48, 1998), Dr. **Andrew Davidson** of Fremantle Hospital in Murdoch proposes that a rise in brain cancer in **Western Australia** between 1982 and 1992 may be linked to the introduction of analog cellular phones. A 1992-1995 decline may be related to the introduction of digital models, his letter suggests. In 1996, Davidson asked **Telstra**, Australia's largest phone company, for access to data for an epidemiological study. "I am still waiting for [a] reply," he writes. Telstra's former chief medical officer, Dr. **Bruce Hocking**, comments in the journal that Davidson's case "is not clear-cut," as the number of analog phone users in Australia is about the same as in 1991. Still, he writes, research is needed and requires phone companies' help: "It is hoped their cooperation will be more forthcoming than Davidson has found." Telstra holds that customer data is private and its release would be illegal. The government's **National Center for Disease Control** in Canberra declares that "small scale, ad hoc research findings which are presented by some doctors as authoritative research projects" are "unnecessarily alarmist." The center calls for "a more rational debate" on mobile phone safety.

The FDA Calls for More Cellular Phone Safety Research, Suggests EMF RAPID Program as a Model

The U.S. Food and Drug Administration (FDA) wants more studies on the safety of hand-held cellular phones. As a model for the research, the agency has endorsed the congressionally mandated program known as EMF RAPID.

The FDA "believes additional research in the area of RF exposure is needed," it told Rep. Edward Markey (D-MA) in a January 14 letter. The FDA letter does not indicate whether it would request federal funds for such a program, but states that it considers safety research to be "the responsibility of the wireless technology industry."

Congress authorized the five-year, \$65 million RAPID research program on EMFs in October 1992, stipulating that industry and the federal government pay equal shares of its cost (see *MWN*, S/O92). The program has been directed by the National Institute of Environmental Health Sciences and the Department of Energy.

The FDA letter, which was signed by Diane Thompson, associate commissioner for legislative affairs, was a response to a November 21 inquiry from Markey, the ranking Democrat on the House telecommunications subcommittee. Markey asked a series of detailed questions concerning the future of RF hazards research and the performance of Wireless Technology Research (WTR), the group set up by the Cellular Telecommunications Industry Association in 1993 in response to public concerns about brain tumors (see *MWN*, J/A93 and N/D97).

In his letter, Markey stressed that he feels "strongly" that it is "incumbent upon the government" to insure that the neces-

sary research on the question of cellular phone safety is conducted. But Markey is still not ready to press for federally funded research on wireless safety (see *MWN*, M/J97).

Markey "will wait and see" whether the FDA requests funds for research in President Clinton's upcoming budget proposal for fiscal year 1999, according to his aide Colin Crowell. If not, "it would be difficult to second-guess the expert agency."

The FDA appears reluctant to endorse a continued role for WTR in investigating wireless health effects. While a WTR-funded study of cellular phone interference with cardiac pacemakers was "well done," the letter stated, "research in biological effects is...more complex." Therefore, WTR's pacemaker research "may not be an adequate model" for studying possible biological effects. In calling on the wireless industry to fund more research, the FDA offered no advice on how to raise the funding.

WTR announced last November 3 that it would not carry out any long-term animal studies, blaming a lack of funds (see *MWN*, N/D97). This decision runs counter to FDA's recommendation to WTR, in a March 13 letter, that lifetime animal studies be given "the highest priority" (see *MWN*, M/A97).

The FDA declined to take a position on whether WTR's audited financial statements should be made more publicly available, as recommended by WTR's peer-review board, based at the Harvard School of Public Health in Boston (see *MWN*, N/D97).

In response to a question on possible health hazards from cellular base stations, the FDA offered no opinion and simply referred Markey to the Federal Communications Commission.

Polish RF/MW—Cancer Data Show Dose-Response Trend

Polish military personnel exposed to radiofrequency and microwave (RF/MW) radiation at levels above 600 $\mu\text{W}/\text{cm}^2$ were almost five times more likely to develop cancer than unexposed personnel, according to a recent analysis. Those exposed to 100-600 $\mu\text{W}/\text{cm}^2$ had a cancer risk nearly twice that of controls.

This increase in cancer incidence with power density is the latest finding of Dr. Stanislaw Szmigielski's long-term research on cancer among Polish servicemen exposed to RF/MW radiation. Szmigielski is at the Center for Radiobiology and Radiation Safety and at the Military Institute of Hygiene and Epidemiology, both in Warsaw.

The new data "for the first time present a hint" of a dose-response relationship between exposure to high-frequency EMFs and cancer, Szmigielski told *Microwave News*. He presented his findings at the *2nd World Congress for Electricity and Magnetism in Biology and Medicine* in Bologna, Italy, last June and later gave *Microwave News* further details of his results.

In 1985, Szmigielski began collecting data prospectively on the types and intensities of RF/MW radiation to which servicemen are exposed. Each year from 1986 through 1990, approximately 3,850 out of 124,500 servicemen aged 25-59 were exposed to levels exceeding 100 $\mu\text{W}/\text{cm}^2$. Most of the sources emitted pulsed radiation, Szmigielski reported.

Szmigielski grouped the RF/MW-exposed cases into four categories. Approximately 1,900 servicemen had "low" exposures (100-200 $\mu\text{W}/\text{cm}^2$); 1,320 had "medium" exposures (200-600 $\mu\text{W}/\text{cm}^2$); some 350 had "above-medium" exposures (600-1,000 $\mu\text{W}/\text{cm}^2$); and 280 had "high" exposures (above 1 mW/cm^2).

The incidence of all cancers was 1.69 times greater in the low-exposure group than among the unexposed controls. Cancer incidence in the medium-exposure group was approximately the same (1.57 times greater).

In contrast, Szmigielski reported finding a "considerably higher" cancer rate in the two highest-exposure groups. In the above-medium group, the risk ratio jumped to 4.63. The highest-exposed group's cancer risk was 4.93 times that of controls.

The dose-response trend apparent in the 1986-1990 data is based on small numbers, Szmigielski cautioned: 36 cases in a "relatively small" group of exposed personnel. "Therefore, each case strongly influences" the risk ratios. A confirming study of a larger population is called for, Szmigielski concluded, in view of the significantly higher cancer rate observed for the two most-exposed groups of servicemen.

An analysis of cancer incidence among exposed and unexposed servicemen in various age groups indicated "considerably higher" cancer rates for the RF/MW-exposed segment of each group. This suggests, Szmigielski said, that cancers "develop faster, with a shorter latency period" in servicemen with occupational RF/MW exposures.

Szmigielski also reported on his latest analysis of retrospective data on cancer incidence in the Polish military, which confirms his earlier finding of substantially elevated cancer risk among personnel whose jobs involved exposure to RF/MW radiation (see *MWN*, Mr85, J/F87 and M/J95). For the 1971-1990 peri-

od, the risk of cancer of all types was 1.83 times greater for the exposed group than for the controls—a highly significant difference.

The morbidity rate for hematological and lymphatic cancers was 5.33 times greater for the exposed servicemen, also a highly significant increase. The higher incidence of brain cancer—2.7 times greater than expected—is also statistically significant.

Szmigielski told *Microwave News* he feels it is too early to publish results of the prospective study. He plans to extend the study with data through 1995.

Still No Solution to Cape Cod Breast Cancer Puzzle

The cause of a 20% excess of female breast cancer on Cape Cod remains a mystery, according to a three-year, \$3.6 million study by the Silent Spring Institute (SSI) in Newton, MA.

The SSI focused on contaminated drinking water and exposure to pesticides, but found no link to the elevated breast cancer rates for 1982-1994. The SSI's report also discounts exposure to power-frequency EMFs and exposure to radiation from the U.S. Air Force's (USAF) PAVE PAWS missile defense radar as possible explanations for the excess.

"We felt there was no evidence that women's exposure to [EMFs or radar radiation] would be different on Cape Cod," Dr. Julia Brody, the institute's executive director and study leader, told *Microwave News*.

For the EMF analysis, Dr. Ann Aschengrau reviewed data from her and Dr. David Ozonoff's 1991 study of cancer on the up-

High-Field Magnetic Stimulation of Brain Reduces Depression

A study of 12 people with clinical depression found that they had a "significantly improved mood" after their brains were stimulated with extremely strong magnetic fields.

At the outset, participants had a mean score of 28.5 on the Hamilton depression scale. In the two weeks of active treatment, this improved by 5.3 points. But when the same people were given a "sham treatment" as a control, the mean score went down by 3.3 points. Which treatment came first was determined at random for each person.

Writing in the December 1997 *American Journal of Psychiatry* (154, pp.1,752-1,756), Drs. Mark George of the Medical University of South Carolina in Charleston and Robert Post of the National Institute of Mental Health in Bethesda, MD, explain that they administered 20 two-second, 20 Hz stimulations over a period of 20 minutes, at a field strength greater than 10,000 G. The sham treatment used the same fields, but with the electromagnet at an angle to the skull instead of alongside it. The researchers state that this "produces a similar sensation in the scalp but appears not to stimulate the brain"; they cite the inability of the angled fields to trigger signals causing muscle movement, and the lack of any changes observed through positron emission tomography.

There were no side effects on memory or attention, and no participants had seizures. Four subjects reported mild headaches after treatment, which were relieved by acetaminophen.

per cape (see *MWN*, J/F92). Both epidemiologists are at the Boston University School of Public Health. Aschengrau investigated occupational EMF exposures based on job classification and residential exposures based on proximity (less than 500 feet) to transmission lines 115 kV and higher. Aschengrau noted, however, "the lack of information on total personal exposure" to EMFs.

The SSI examined patterns of breast cancer incidence near the PAVE PAWS radar in Bourne, using radiation measurements made by the USAF in 1978 and 1986. (In the mid-1980s, the USAF was planning to raise the power output of the radar by a factor of four; see *MWN*, M/J87). While noting that higher cancer levels were reported for some census tracts, they found no overall pattern of increased incidence in areas that the USAF data suggested were exposed.

In the November/December 1996 issue of *Public Health Reports*, Brody wrote that, "The EMF hypothesis...was given low priority in our study." Radiation from PAVE PAWS was not cited there as a possible risk factor.

The study was sponsored by the Massachusetts Department of Public Health. To obtain a copy of *The Cape Cod Breast Cancer and Environment Study*, contact: SSI, 29 Crafts St., Newton, MA 02158, (617) 332-4288, Fax: (617) 332-4284, E-mail: <info@silent.shore.net>, Web site: <www.silentspring.org>.

IARC Embarks on Major Study of Cancer and Mobile Phones

The International Agency for Research on Cancer (IARC) in Lyon, France, is planning a multicountry, multimillion-dollar study of cancer among users of hand-held wireless phones. A feasibility study is under way and the main study is scheduled to start next year.

"Because of the huge increase in users, clearly we have a duty at the IARC to monitor the health impacts of mobile phones," Dr. Elisabeth Cardis, the study's principal investigator, told *Microwave News*. But, she added, "All the evidence to date points to the fact that there is no major health risk." Cardis, a biostatistician and epidemiologist, heads the IARC program on radiation and cancer.

The pilot study, costing approximately \$250,000, will investigate tumors of the acoustic nerves and salivary glands, as well as two types of brain tumors—meningiomas and gliomas. "We want to focus on the most-exposed areas of the head," Cardis said. The researchers will then determine which types of cancer to include in the main study.

Cardis is satisfied that cellular phones have been in use long enough for any increase in cancer to be detectable. "You should be able to see a risk after five years," she contended. Cardis explained that the evidence indicates that while RF may be involved in promotion or progression of cancer, it does not cause it, and the latency period would therefore be shorter.

One potential problem, Cardis noted, is that "the technology of mobile phones keeps changing"—and with it, users' exposures.

To achieve a sufficiently large study population, Cardis will collaborate with researchers in Australia, Canada, France, Israel, Italy, Sweden and the U.K. An eighth country, which Cardis declined to name, may also participate.

Light Behind the Knee Shifts Circadian Rhythms

In a remarkable study, visible light applied to the back of the knee has been shown to cause significant shifts in human circadian rhythms.

Drs. Scott Campbell and Patricia Murphy of Cornell University Medical College in White Plains, NY, exposed the skin at the back of each participant's knee to a 13,000 lux light source for three hours. A fiber-optic pad was used to transmit the light without transmitting heat, and an opaque "skirt" was placed around the legs so that no light could escape. "Illumination at the participant's eye level never exceeded 20 lux," Campbell and Murphy write in the January 16 *Science* (279, pp.396-399).

In all 15 subjects, "there was a systematic relation between the timing of the light pulse and the magnitude and direction of the...shift" in circadian rhythms. Administering the light early in the normal sleep cycle caused a delay in the drop in body temperature and the rise in melatonin level that normally occur at night. When light was applied late in the normal sleep cycle, these rhythms began earlier.

It has long been known that light in the eye can be used to alter body rhythms. Campbell and Murphy note, however, that bright light can suppress melatonin levels in some humans who are completely blind. This and other evidence had led scientists to conclude that there must be other photoreceptor cells that are not involved in vision—but they had expected these cells to be located inside the eye.

In an accompanying commentary, Drs. Dan Oren of Yale University in New Haven, CT, and Michael Terman of Columbia University in New York City suggest that the effect of light behind the knee may be caused by "pigments [in the blood] such as hemoglobin and bilirubin." As Oren told Reuters on January 29, the idea is that "blood is a messenger for light, and that blood absorbs light through the eyes and in the skin."

Cardis believes the multicountry format will enable the study to identify even a small increase in risk. "My opinion is that we should have a sufficiently large population with sufficiently large exposures." Cardis said the study will look at a relatively young population.

Established in 1965, the IARC is a semi-independent agency of the World Health Organization (WHO) that coordinates and conducts epidemiological as well as *in vivo* and *in vitro* research.

The impetus for the study came from WHO's EMF project, which recommended a large-scale epidemiological study of cancer in cellular phone users at its meeting on RF health effects in Munich, Germany, in November 1996 (see *MWN*, J/A96). "We are doing this in response to the Munich meeting," said Cardis, who has participated in several EMF project workshops.

The IARC's Swedish collaborator for the study is Dr. Lennart Hardell of the Örebro Medical Center. Hardell is also leading a case-control study of cellular phone use among brain cancer patients, sponsored by the Swedish Work Environmental Fund. (For more on Hardell's study and other ongoing epidemiological studies see *MWN*, N/D97.)

public, Motorola contracted with Roti Roti to see if he could reproduce the effect (see *MWN*, N/D94 and J/F95). While Wire-
less Technology Research (WTR), which is sponsored by the cellular phone industry, has long talked about trying to repeat the Lai-Singh experiments, its studies have not yet gotten under way.

Both the Roti Roti-Malyapa and Lai-Singh labs used the comet assay—also known as microgel electrophoresis—to measure DNA breaks. In the assay, DNA fragments spread out like the tail of a comet.

But each lab favors a different variant of the technique. Roti Roti and Malyapa used the assay developed by Dr. Peggy Olive of the British Columbia Cancer Research Centre in Vancouver, Canada, while Lai and Singh used the assay developed by Singh himself.

Lai and Singh argue that the Olive assay cannot detect microwave effects. The Singh method uses proteinase K, an enzyme that digests proteins that may be bound to the DNA, while Olive's does not. "Digestion with this enzyme is an essential step," Lai said. "When we do not use proteinase K, we do not see an effect with microwaves either." Lai explained that microwaves can induce protein-DNA cross-links that must be broken up before the comet analysis is carried out.

"The use of proteinase K is not necessary to achieve a sensitive assay to determine DNA damage from ionizing radiation," Roti Roti told *Microwave News*. "It is only important if there are protein-DNA cross-links, and there is no mention of any such cross-links in the Lai-Singh published papers," he said.

There is also a heated dispute over the sensitivity of the Olive assay as reported by Roti Roti and Malyapa. Lai and Singh are troubled by what they say are Roti Roti and Malyapa's impossible claims that the Olive assay can detect damage by very low levels of ionizing radiation. Lai and Singh conclude that Roti Roti and Malyapa simply cannot be using the assay correctly and, if so, their results for microwaves, including cellular phone signals, cannot be trusted either.

Roti Roti and Malyapa contend that they can observe DNA breaks following gamma ray exposure at doses as low as 0.6 cGy (0.6 Rads). The sensitivity of their assay is much greater than Olive has claimed in her own papers. Roti Roti and Malyapa themselves point this out in *Radiation Research*: "This report is the first of its kind to measure DNA damage at low doses using the [Olive] method."

Singh does not believe that this kind of sensitivity is possible with the Olive assay. And Olive herself has doubts.

In an interview, Olive said that she "can't get down that far," while acknowledging that she is not using exactly the same method as Roti Roti and Malyapa. "While detecting DNA damage at 1 cGy is possible, 5 cGy is more realistic," she said.

Olive pointed out that for replicating cells, like the human brain tumor cells and mouse fibroblasts used by Roti Roti and Malyapa, "You have a high background of damage, which makes it difficult to see a small effect."

When asked about the reported sensitivity of his assay, Roti Roti responded that it is reasonable because his data fit with previous experimental results. "We are no more or less sensitive relative to dose-response curves published in the literature," he

stressed.

Roti Roti further argued that Olive had in fact stopped collecting data at 50 cGy. "She did not push it to lower doses. She did not run out of sensitivity," he said. Malyapa was out of the country and could not be reached for comment.

Olive confirmed that she had not experimented with low levels. "We are interested in clinical doses in the Gy range," she said.

Roti Roti and Malyapa address the criticisms on the sensitivity of the Olive assay in a "short note" that has also been accepted for publication in *Radiation Research*. "It was handled by a different associate editor and new reviewers," Roti Roti said, adding that there were six reviewers for this note. Roti Roti declined to comment further or to make a copy available prior to publication, at the request, he said, of the editors of *Radiation Research*.

Martha Edington, the managing editor of *Radiation Research*, would not say when Roti Roti's note would appear: "I am not at liberty to provide information about any papers that may appear in upcoming issues of the journal," she told *Microwave News*.

"Both sets of data are confusing," Dr. Ray Tice of Integrated Laboratory Systems said in an interview from his office in Research Triangle Park, NC. "I am surprised by Roti Roti's ability to detect DNA damage in the cGy range using the Olive method. On the other hand, I am equally surprised by Lai and Singh's positive response with microwaves."

Tice is working with WTR to try to repeat the Lai-Singh experiments, but that effort is still on hold pending receipt of funding (see also p.8).

Tice said he is "very surprised" by the Roti Roti-Malyapa decision to use the Olive method. "Not too many scientists are using the Olive method. Most use Singh's," he said.

"It was my decision. I take the full responsibility for using the Olive method," Roti Roti said. "We could gain more information more rapidly than by using the Singh method." He added that, "There is no theoretical reason why the methods should give different results for measuring strand breaks."

"In any case," Roti Roti added, "at the time I designed this project with [Motorola's Dr.] Q. Balzano, WTR had announced it was funding three groups to repeat the Lai-Singh study. I thought there would be three other papers in the literature by now. They were way ahead of me when I started."

In their paper, Roti Roti and Malyapa write that the Olive assay was chosen "because it is simple and inexpensive and the results are reproducible." Olive is a consultant to his project, Roti Roti said.

Tice underscored the "apparent very good reproducibility" of the Roti Roti-Malyapa data. "Reproducibility is the hallmark of biological significance," he said.

But Lai and Singh are troubled by the similarity of Roti Roti and Malyapa's dose-response curves for the two different cell lines. In each case, the curves start to flatten out at relatively low levels of gamma radiation.

"The curves show saturation at 3-5 cGy," said Lai. "That's not possible. It is very strange." Singh agreed. "The curves look wrong," he said. "They should not be curving downwards."

Olive said that she too has a "problem" with the dose-response data. "There seems to be a different effect going on at low

Cellular Phone Radiation and Single-Strand DNA Breaks: Sensitivity to Very Low Levels—Beneficial Effects Seen

Dr. Jerry Phillips of the VA Hospital in Loma Linda, CA, has also been using the comet assay and he has some intriguing results.

First, Phillips has found that human cancer cells in culture respond to extremely low levels of microwave radiation—levels that are more than a thousand times below those assumed to be safe under current health standards. Second, he has observed potentially beneficial effects under a variety of exposure conditions, suggesting that microwaves could promote DNA repair.

Perhaps the most tantalizing aspect of Phillips's experiments is that a cellular phone signal that decreased single-strand DNA breaks *in vitro* at two different exposure levels had previously been shown to provide protection against brain tumors in exposed rats.

"Our studies indicate that microwaves have nonthermal, signal-specific effects that might sometimes do good and might sometimes do harm," Phillips told *Microwave News*. "They support the hypothesis that modulation and exposure duration are key determinants of a signal's biological impact."

Phillips exposed human leukemia cells to either of two different types of microwave radiation used in wireless communications: 813 MHz iDEN and 836 MHz TDMA signals. He used the comet assay developed by Dr. N.P. Singh.

Significantly decreased DNA damage was observed in cells

exposed to the TDMA signal at an SAR of 2.6 mW/Kg for 2 hours or for 21 hours, as well as at an SAR of 26 mW/Kg for 2 hours. (Current standards assume exposures below 4 W/Kg are safe.)

When Phillips used the iDEN signal with an SAR of 2.4 mW/Kg for 2-hour and 21-hour exposures, he again found less DNA damage. But when the SAR was increased to 24 mW/Kg, he saw significantly more damage.

In 1996, Dr. Ross Adey reported that rats exposed to an 836 MHz TDMA signal at an SAR of 0.58-0.75 W/Kg had significantly fewer central nervous system tumors than did controls (see *MWN*, M/J96 and J/A96). When Adey used an FM continuous signal, like that used by analog cellular phones, he found no effect on tumor incidence (see *MWN*, M/A97). Adey recently stepped down as the head of the Loma Linda VA lab. Adey's and Phillips's studies were both sponsored by Motorola.

In explaining why he sometimes sees more DNA damage and sometimes less damage, Phillips said that the reactions that play a role in DNA damage and repair are not yet well understood.

"We believe the key to interpreting such data lies in understanding the balance that exists between DNA damage and the repair of that damage," he writes in a paper that has been accepted for publication in *Bioelectrochemistry and Bioenergetics*.

doses," she explained, adding that, "There are not enough data in the [Roti Roti] paper to draw conclusions about the shape of the curves at higher exposures."

In a paper she published in 1992, Olive reported that Chinese hamster fibroblasts showed a linear dose-response from 200 cGy to 100 Gy.

Roti Roti and Malyapa address these concerns in print. While they concede that their dose-response curves "appear to reach a plateau" at low doses, they write that they completed dose-response curves up to 10 Gy and that the comet length increased linearly with dose at higher exposures. These data are not shown in *Radiation Research*.

The second paper by Roti Roti's team, on exposures of rats at 2450 MHz with an SAR in the brain of 1.2 W/Kg, has also been accepted by *Radiation Research*. These data, which do not show a microwave effect, were presented last June at the *2nd World Congress for Electricity and Magnetism in Biology and Medicine* in Bologna, Italy. Roti Roti said that he did sometimes see an effect but that it was a function of the way the animals were sacrificed, not the microwave exposures.

The differences between the Washington University and University of Washington labs may be resolved as others run their own comet assays. For instance, Dr. Jerry Phillips of the VA Hospital in Loma Linda, CA, is seeing both microwave-induced DNA repair and breaks using the Singh assay (see box above).

In France, Dr. Bernard Veyret of the University of Bordeaux will begin exposing both cells and animals to microwaves in February. Veyret will be using the Singh assay. He told *Microwave News* that he expects to have some results before this summer.

Roti Roti said that he is committed to finding out what is going on biologically and to finding the reason for the discrepancy between his lab and Lai and Singh's lab. He expressed dismay at the lack of a resolution of a number of possible EMF effects in the published literature.

"Motorola will support our lab to get to the bottom of the issue," Roti Roti said. He and Motorola have recently completed negotiations on a contract renewal, which will allow his lab to do more experiments with digital microwave signals and with higher SARs and to pursue the differences between his results and those of Lai and Singh. "I believe in making the effort to try to resolve the differences," he said.

"The real bottom line is whether there is a health hazard," Roti Roti said.

Daryl Fairbairn, Peggy Olive and Kim O'Neill, "The Comet Assay: A Comprehensive Review," *Mutation Research*, 339, pp.37-59, 1995.

Robert Malyapa et al., "Measurement of DNA Damage After Exposure to 2450 MHz Electromagnetic Radiation," *Radiation Research*, 148, pp.608-617, 1997.

Robert Malyapa et al., "Measurement of DNA Damage After Exposure to Electromagnetic Radiation in the Cellular Phone Communication Frequency Band (835.62 and 847.74 MHz)," *Radiation Research*, 148, pp.618-627, 1997.

P.L. Olive et al., "Factors Influencing DNA Migration from Individual Cells Subjected to Gel Electrophoresis," *Experimental Cell Research*, 198, pp.259-267, 1992.

Narendra Singh et al., "A Simple Technique for Quantitation of Low Levels of DNA Damage in Individual Cells," *Experimental Cell Research*, 175, pp.184-191, 1988.

N.P. Singh, R.E. Stephens and E.L. Schneider, "Modifications of Alkaline Microgel Electrophoresis for Sensitive Detection of DNA Damage," *International Journal of Radiation Biology*, 66, pp.23-28, 1994.

FROM THE FIELD

Clippings from All Over

"[R]esearch on EMFs in the United States will take a big nosedive."

—Dr. Charles Graham, Midwest Research Institute, Kansas City, MO, quoted by Janet Raloff in "EMFs' Biological Influences," *Science News*, p.31, January 10, 1998

"We were all flabbergasted....For three days we tried to find flaws in the experiment and we couldn't."

—Dr. Michael Menaker, University of Virginia, Charlottesville, quoted by Sandra Blakeslee in "Study Offers Surprise on Working of Body's Clock," *New York Times*, p.20, January 16, 1998 (see p.11)

"The answer here is not for the heavy hand of federal government to just roll over local municipalities....I've told the wireless industry and the broadcasting industry that they've got to work with local governments to solve this problem....Until that dialogue takes place, preemption shouldn't even be considered."

—William Kennard, chairman, Federal Communications Commission, quoted by Jeffrey Silva in "Kennard: Compromise on Siting," *RCR*, pp.1,46, February 2, 1998

"We want to be a good neighbor, that's why we have our stealth policy."

—Mary Ann Noyer, spokesperson for AT&T Wireless, referring to the company's policy of hiding antennas where possible and sharing sites with other companies, quoted by Andrew Revkin in "It's a Tree! It's a Cactus," *New York Times*, p.25, January 11, 1998

A[n] officer recounted [the mishap of] a driver who had dialed a pay-per-minute adult entertainment phone service. He lost control of his vehicle and hit a dump truck head-on. He was fatally injured and died with the cellular telephone still in his hand.

—National Highway Transportation Safety Administration (NHTSA), *An Investigation of the Safety Implications of Wireless Communications in Vehicles*, p.40, November 1997 (released January 1998) (see p.16)

[W]ireless doesn't cause accidents on the road. Subscribers with poor judgment do. They allow phone-number fumbling, dialing or conversing to subvert their primary duty: attention to the road.

—Rikki Lee, news editor, in an editorial on the NHTSA report, "Driven To Distraction," *Wireless Week*, p.40, January 19, 1998

"I don't use cellular phones...it's like sticking your head in a microwave oven. They're very bad for you."

—Keith Richards of the Rolling Stones, quoted by Chris Heath in "Keith Richards: 'Throw Me One of Those Bones, We'll Eat It Forever,'" *Rolling Stone*, p.92, December 25, 1997-January 8, 1998

"He believes using [mobile] phones is like putting your head in a microwave oven."

—Michael Cole, spokesman for Mohamed Al Fayed, owner of Harrods, quoted by Robert Uhlig in "Health Fears But No Real Evidence," *Daily Telegraph* (U.K.), December 2, 1997 (see also *MWN*, N/D97)

"Anyone who uses a mobile telephone for more than 20 minutes at a time needs to have their brain tested."

—Roger Coghill, Coghill Research Labs, Gwent, Wales, U.K., quoted in "Mobile Phones Assailed," *International Herald Tribune*, p.9, January 12, 1998

On the evidence to date, there is no proven risk of brain cancer from mobile phones (or other communication devices), and the mechanism of effects at low levels of exposure to radiofrequency fields is unclear. However, mobile phones have been widely used for less than a decade and there are grounds to be cautious.

—Dr. Bruce Hocking, consultant based in Melbourne, Australia, and former chief medical officer of Telstra, in a letter to the *Medical Journal of Australia*, p.48, January 5, 1998 (see p.9)

"As far as mobile telephony is concerned, we have concluded that the compiled results of many years of international research do not show that the electromagnetic fields generated by base stations and mobile telephones cause any risk to health."

—Lars Ramqvist, chief executive, Ericsson, quoted by Helen Meredith in "Mobile Phones: the Fears That Can't Be Quelled," *Australian Financial Weekly*, p.22, January 10-11, 1998

The U.K. has over eight million mobile phone users. Teenagers are part of one of the largest groups of new mobile phone subscribers. Are governments and the industry doing all they can to safeguard their health?

—Editorial, "Time To Resolve Mobile Risks...," *Electronics Weekly* (U.K.), p.16, January 14, 1998

"MICROWAVE NEWS" FLASHBACK

Years 15 Ago

- The EPA announces that it will end its RF/MW research program, despite the agency's intention to develop an RF/MW safety standard.
- Dr. Nancy Wertheimer and Ed Leeper report an increase in cancer rates among adults exposed to power line EMFs.
- Robert Engell settles his \$4.5 million lawsuit against ITT in which he alleged that his pancreatic cancer was caused by tactical air navigation equipment manufactured by ITT. The terms are not disclosed.

Years 10 Ago

- Concerns are raised that a large Voice of America shortwave transmitter could be a possible risk factor in the McFarland, CA, childhood cancer cluster.
- Writing in *Nature*, two engineering professors, Drs. Kenneth Foster and William Pickard, call for an end to research on RF/MW health

effects. Dr. Samuel Koslov of the Johns Hopkins University Applied Physics Lab responds, "I get the impression that the authors have not bothered to follow the field for at least five years."

- An F-16 pilot who was accidentally overexposed to radar radiation continues to complain of short-term memory loss long after other effects have disappeared.

Years 5 Ago

- The CTIA announces plans for a health research program to calm fears among the public and investors after David Reynard claims his wife's brain tumor was caused by her cellular phone.
- The Colorado Public Utilities Commission begins requiring that electric utilities exercise prudent avoidance by considering health impacts in siting new power lines.
- A jury rejects police officer Eric Bendure's claim that his non-Hodgkin's lymphoma was caused by a radar gun made by Kustom Signals Inc.

CONFERENCES

1998 Conference Calendar (Part II)

Web site addresses are in italics. Part I appeared in our last issue.

March 10-12: **Workshop on Control of Workplace Hazards for the 21st Century** (includes non-ionizing radiation), Hyatt Regency Hotel, Chicago, IL. Contact: Dr. Gregory Lotz, NIOSH, Mail Stop C-27, 4676 Columbia Parkway, Cincinnati, OH 45226, (513) 533-8153, Fax: (513) 533-8510, E-mail: <wgl0@niobbs1.em.cdc.gov>, <www.cdc.gov/niosh/homepage.html>.

April 9-10: **24th IEEE Northeast Bioengineering Conference**, Hershey Lodge and Convention Center, Hershey, PA. Contact: Seth Wolpert, Dept. of Electrical Engineering, Penn State-Harrisburg, 777 W. Harrisburg Pike, Middletown, PA 17057, (717) 948-6752, E-mail: <sxw33@psu.edu>.

June 7-11: **1998 Annual Meeting of the Bioelectromagnetics Society**, Trade Winds Hotel, St. Petersburg, FL. Contact: Dr. William Wisecup, W/L Associates, 7519 Ridge Rd., Frederick, MD 21702, (301) 663-4252, Fax: (301) 371-8955, E-mail: <75230.1222@compuserve.com>, <biomed.ucr.edu/bems.htm>.

June 7-12: **1998 IEEE MTT-S International Microwave Symposium and 51st Automatic RF Techniques Group (ARFTG) Conference**, Baltimore, MD. For MTT-S, contact: Ed Niehenke, (410) 796-5866, Fax: (410) 796-5829, E-mail: <e.niehenke@ieee.org>, <www.mtt.org>. For ARFTG, contact: John Gregory Burns, Northrop Grumman, PO Box 1521, Mail Stop 3K13, Baltimore, MD 21203, (410) 765-7331, E-mail: <burns.john@postal.essd.northgrum.com>.

June 15-24: **RAPID Science Working Group Meeting**, Northland Inn and Conference Center, Minneapolis, MN. Contact: Dr. Mary Wolfe, NIEHS, PO Box 12233, Research Triangle Park, NC 27709, (919) 541-7539, Fax: (919) 541-0144, E-mail: <wolfe@niehs.nih.gov>.

June 21-26: **1998 IEEE Antennas and Propagation Society International Symposium and URSI North American Radio Science Meeting**, Renaissance Waverly Hotel, Atlanta, GA. Contact: Wilson Pearson, Dept. of Electrical and Computer Engineering, PO Box 340915, Clemson University, Clemson, SC 29634, (864) 656-3946, Fax: (864) 656-3946, E-mail: <apsursi98tpc.info@ces.clemson.edu>, <seal.gatech.edu/EEED/AP-URSI98/ap-ursi98.htm>.

June 23-25: **14th International Wroclaw Symposium and Exhibition on Electromagnetic Compatibility (EMC)**, Wroclaw, Poland. Contact: W. Moron, EMC Symposium, Box 2141, 51-645 Wroclaw 12, Poland, (48+71) 728-812, Fax: (48+71) 728-878, E-mail: <emc@il.wroc.pl>.

June 24-26: **31st Annual Meeting of the Society for Epidemiologic Research (SER)**, Marriott Downtown Hotel, Chicago, IL. Contact: Sandy Adams, SER, 111 Market Pl., Suite 840, Baltimore, MD 21202, (410) 223-1626, Fax: (410) 223-1620, E-mail: <stacey@caat.spharbor.jhu.edu>, <www.sph.jhu.edu/pubs/jepi>.

July 6-10: **1998 Conference on Precision Electromagnetic Measurements**, Renaissance Hotel, Washington, DC. Contact: Carla Battle, Courtesy Associates, 2000 L St., NW, Suite 710, Washington, DC 20036, (202) 347-5900, E-mail: <cbattle@courtesyassoc.com>, <www.eeel.nist.gov/cpem98>.

July 11-15: **33rd Microwave Power Symposium**, Inter-Continental Hotel, Chicago, IL. Contact: International Microwave Power Institute, 10210 Leatherleaf Ct., Manassas, VA 20111, (703) 257-1415, Fax: (703) 257-0213, E-mail: <AssnCtr@idsonline.com>.

July 12-16: **43rd Annual Meeting of the Health Physics Society (HPS)**, Minneapolis, MN. Contact: HPS, 1313 Dolley Madison Blvd., Suite 402, McLean, VA 22101, (703) 790-1745, Fax: (703) 790-2672, E-mail: <hpsburkmgmt@aol.com>.

July 12-16: **1998 IEEE Power Engineering Society Summer Meeting**, Sheraton Hotel, San Diego, CA. Contact: Terry Snow, San Diego Gas & Electric, PO Box 1831, San Diego, CA 92112, (619) 696-2780, Fax: (619) 699-5096, E-mail: <t.snow@ieee.org>, <www.ieee.org/power>.

July 13-17: **Progress in Electromagnetics Research Symposium (PIERS 1998)**, Congress Center, Nantes, France. Contact: Dr. Le Toan, CESBIO, BPI 2801, 18 Ave. E. Belin, F-31401 Toulouse Cedex 4, France, Fax: (33+5) 61 55 85 00, E-mail: <thuy.letloan@cesbio.cnes.fr>, <www.treste.fr/piers98>.

August 18-20: **International Conference on Microwave and Millimeter Wave Technology**, Beijing, China. Contact: Ms. Fang Min, Chinese Institute of Elec-

tronics, PO Box 165, Beijing 100036, China, (86+10) 682-83463, Fax: (86+10) 682-83458, E-mail: <shaz@sun.ihep.ac.cn>, <www.cie-china.org>.

August 23-28: **1998 IEEE International Symposium on Electromagnetic Compatibility**, Denver, CO. Contact: LRW Associates, PO Box 2530, Matthews, NC 28106, (704) 841-1915; or Dr. Matohisa Kanda, NIST, 325 Broadway St., Boulder, CO 80303, (303) 497-5320, Fax: (303) 497-6665, E-mail: <m.kanda@ieee.org>.

September 14-18: **1998 International Symposium on Electromagnetic Compatibility**, University of Rome "La Sapienza," Italy. Contact: Daniela Fioramonti, AEI-Ufficio Centrale, Piazzale R. Morandi 2, 20121 Milan, Italy, (39+2) 777-901, Fax: (39+2) 798-817, E-mail: <conferencesaei@aei.it>, <www.aei.it/emc98roma.html>.

September 24-25: **Mechanisms and Consequences of Power-Frequency Electromagnetic Field Exposure**, University of Bristol, U.K. Contact: Dr. Alan Preece, Medical Physics Research Centre, University of Bristol, Horfield Rd., Bristol BS2 8ED, U.K., (44+117) 928-2469, Fax: (44+117) 928-2470, E-mail: <a.w.preece@bristol.ac.uk>, <www.bris.ac.uk/depts/medphys/>.

October 14-16: **1998 International Conference on Harmonics and Quality of Power**, Athens, Greece. Contact: Conference Secretariat, National Technical University of Athens, Electric Energy Systems Lab, PO Box 26137, Athens 10022, Greece, (30+1) 772-3598, Fax: (30+1) 772-3659, E-mail: <harna@power.ece.ntua.gr>.

October 29-November 1: **20th Annual International Conference of IEEE Engineering in Medicine and Biology Society**, Convention and Exhibition Center, Hong Kong, China. Contact: EMBSU98, HKIE, 9/F, Island Center, No. 1 Great George St., Causeway Bay, Hong Kong, China (852) 2895-4446, Fax: (852) 2588-7791, E-mail: <embsc@ee.cuhk.edu.hk>, <www.ee.cuhk.edu.hk/embs98.html>.

November 9-12: **43rd Conference on Magnetism and Magnetic Materials**, Miami, FL. Contact: Diane Suiters, Courtesy Associates, 2000 L St., NW, Suite 710, Washington, DC 20036, (202) 973-8668, Fax: (202) 331-0111, E-mail: <magnetism@courtesyassoc.com>.

November 17-19: **10th International Symposium on Antennas (JINA 98)**, Nice, France. Contact: JINA 98, France Télécom/CNET, Fort de la Tête de Chien, F-06320 La Turbie, France, Fax: (33+4) 92 10 65 19, E-mail: <jina.cnet@wanadoo.fr>, <13s.unice.fr/JINA-98>.

NIOSH Workshop on Technology for Controlling Non-Ionizing Radiation

The National Institute for Occupational Safety and Health (NIOSH) is cosponsoring a March 10-12 workshop in Chicago on controlling non-ionizing radiation (NIR) exposures and other workplace health risks. The spectrum from ELF through RF/MW radiation to infrared, visible and UV radiations, as well as lasers, will be covered.

"This represents a new area of interest for NIOSH. We have not focused on control technologies before," said Dr. Gregory Lotz, chief of NIOSH's Physical Agents Effects Branch.

One of the other major areas of discussion will be the use of protective clothing.

Dr. James Melius, a member of the National EMF Advisory Committee, will be a featured speaker. William Feero of Electric Research and Management in State College, PA, will address ELF EMFs. The speaker on RF/MW radiation had not been finalized at press time.

To set a framework for discussion at the workshop, NIOSH has released a four-page "white paper" on *Research Needs for Non-Ionizing Radiation*. A copy of the NIOSH white paper is posted on the institute Web site. For the Internet address and for more information, see the listing on the left.

CELLULAR PHONES & DRIVING

Some Added Risk, Says NHTSA ... Does using a cellular telephone while driving increase the risk of a crash? The answer is, "Yes, at least in isolated cases," according to a new report from the National Highway Traffic Safety Administration (NHTSA). In response to public concern and the proliferation of legislative attempts to restrict wireless phone use while driving, the NHTSA reviewed more than 30 relevant epidemiological and behavioral studies. This is a polarized issue, Michael Goodman, the NHTSA's technical manager for the report, told *Microwave News* from his office in Washington, explaining that many drivers rely on phones for business reasons, while others feel endangered by phone-wielding drivers. The NHTSA, said Goodman, sought to present "an objective set of data" with which policymakers, the cellular industry and the public could "reach their own conclusions." Noting the "inherent distraction potential" of the phones, the report suggests that cellular phones increase the risk of accidents to an extent "similar to that associated with other distractions," such as reading a map. However, the report stops short of accepting the finding of a fourfold increase in accident risk reported by Canadian researchers last February in the *New England Journal of Medicine* (see *MWN*, M/A97). The NHTSA contends that the data are "insufficient" for such a conclusion. "We know cellular phones can cause crashes," Goodman commented. "What we don't know is how many crashes they cause." The report nevertheless predicts that the rapid spread of wireless technology will bring "an associated increase in related crashes" unless phone technology or motorists' habits change. The wireless industry cooperated with the NHTSA for the report, said Tim Ayers of the CTIA in Washington. But, he added, it presents "nothing conclusive." The NHTSA calls for improved reporting and data collection on the role of phones in accidents, further research on the problem, increased consumer education and more vigorous enforcement of laws against reckless or inattentive driving. The 274-page report also gives details of laws restricting cellular phone use while driving that have been adopted or proposed in 14 states in the U.S. and in many countries around the world. The NHTSA questions the value of laws requiring "hands-free" car phones—already in force in several countries—in view of evidence that phone conversations distract drivers more than placing or receiving calls. Copies of the report, *An Investigation of the Safety Implications of Wireless Communications in Vehicles*, are available from: U.S. Department of Transportation TASC, Subsequent Distribution Office, SVC-121.23, Ardmore East Business Center, 3341 Q 75th Ave., Landover, MD 20785, Fax: (301) 386-5394. Requests should include the report's title and document number: DOT HS 808-635.

MELATONIN

Try Counting Sheep Instead... Attempts to debunk the media hype on melatonin have focused on some of the more dubious claims—that it will make you younger or improve your sex life. Now comes word that it may not be all that useful as a sleep aid, either. A special section in the journal *Sleep* (20, pp.898-919, 1997), released in December, examines the data in three articles and an editorial. Dr. Wallace Mendelson of the University of Chicago's Sleep Research Laboratory writes that current evidence

does not support the general use of melatonin to combat insomnia. While several studies have found that melatonin can shorten the time needed to fall asleep, Mendelson states, they have not shown any clear effect on total sleep time or its quality. He notes that in a Consumer's Union survey, melatonin was rated "not at all helpful" more than any other sleep aid, and was called "very helpful" by only one quarter of respondents. In another article, Dr. Robert Sack of Oregon Health Sciences University in Portland gives a similar assessment of the literature. But Sack points out that melatonin supplements can shift the timing of an individual's circadian rhythm, and that "optimal alignment of the circadian phase with desired sleep time is a critical ingredient of good sleep." In fact, Sack argues that since melatonin is associated with awakening and activity in nocturnal animals, it would best be described as a "darkness hormone" rather than as a "sleep hormone" across all species. Another contributor, Dr. Irina Zhdanova of MIT in Cambridge, MA, contrasts melatonin with prescription sleep drugs: Unlike the latter, melatonin does not produce "unbearable tiredness and an irresistible sleep drive." Rather, in her studies, it produced "general relaxation...and an easier transition to sleep." Sack makes the same distinction, pointing out that increasing doses of a barbiturate or a benzodiazepine lead to "increasing degrees of sleepiness and eventually coma." But doses of melatonin over 1,000 times those that occur naturally never lead to loss of consciousness—in fact, they may not even make some people feel sleepy. Sack adds that the studies that show melatonin having the strongest soporific effect in the daytime were conducted with young subjects: "Many were presumably students and...probably somewhat sleep-deprived." He suggests that a built-up "sleep debt" may be necessary for melatonin to lead to "manifest sleepiness." Zhdanova warns that melatonin tablets sold in health food stores, "peculiarly labeled a 'dietary supplement'," produce levels many times higher than those normally found in the body, and that this hormone affects tissues as diverse as the brain, pituitary gland, gonads and blood cells. An editorial by the section editor, Dr. Meir Kryger of the University of Manitoba in Winnipeg, Canada, points out that melatonin supplements are a totally unregulated product, and that "one cannot be comfortable that the pill contains what it says it contains." In fact, in Canada and Europe, melatonin cannot be purchased over the counter.

Herbal Sources... Researchers have found that several herbal remedies contain melatonin, including the popular St. John's Wort, as well as feverfew and Huang-qin. In the November 29, 1997, issue of the *Lancet*, a team from the University of Guelph in Ontario, Canada, reports that St. John's Wort contains melatonin at levels of up to 4.39 µg/g. Huang-qin had the highest concentration—7.11 µg/g—and feverfew up to 2.45 µg/g. The December 14, 1997, *New York Times* reports that demand for St. John's Wort, most often used to treat mild depression, has jumped in recent months. Feverfew has been found effective in treating migraine and Huang-qin is recommended for nervous system ailments.

OCCUPATIONAL HEALTH

EPRI Reviews Exposure Guidelines... Standard-setting bodies should "strengthen and clarify" the scientific basis for the limits

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they prescribe—so concludes EPRI's *Evaluation of Occupational Magnetic Field Exposure Guidelines*. The 141-page report surveys the scientific rationales and operational guidelines for power-frequency exposure limits issued by the U.S.'s ACGIH, the U.K.'s NRPB, Germany's DIN/VDE, CENELEC and IRPA. None takes into account “potential long-term effects, such as cancer”; rather, all are intended to insure that induced current densities in tissue do not exceed 10 mA/m², the threshold for cardiac and nervous stimulation. The EPRI report, authored by Dr. Dan Bracken, a consultant based in Portland, OR, also compiles data on utility workers' exposures to fields above 500 mG from five utility-sponsored studies. For copies of the report, contact: EPRI Distribution Center, 207 Coggins Dr., PO Box 23205, Pleasant Hill, CA 94523, (510) 934-4212.

PACEMAKER EMI

ELF Fields and Pacemakers...Power-frequency EMFs can interfere with the function of implanted pacemakers and defibrillators, according to a literature review sponsored by EPRI. Although present-day pacemakers are better shielded than earlier designs, some vulnerability to EMI is “inevitable,” writes Dr. Antonio Sastre of A.S. Consulting & Research in Kansas City, MO, the report's author. (Sastre is also a senior scientist at the Midwest Research Institute.) But, “It is possible to devise engineering solutions that minimize risk,” Sastre told *Microwave News*. Threshold intensities for interference vary widely among manufacturers and design types, according to the report. Most susceptible are dual-chamber units, including those operating in monopolar mode, which can malfunction in 50/60 Hz fields as low as 2 G or 1.5 kV/m. While this is far above any EMF levels found inside most homes, Sastre pointed out that 1.5 kV/m fields are “not uncommon” in the U.S. “You have that under 115 kV and 230 kV power lines in many residential areas.” The most immune models can function normally in magnetic fields as strong as 12 G and in electric fields up to 20 kV/m. EMI-induced malfunctions are “mostly benign,” the report states, and usually involve reversion to fixed-rate pacing. Most devices return to normal operation when the EMI event is over. Malfunctions can be serious, however, in wearers who depend on their pacemakers to maintain cardiac rhythm, who have units operating in inhibited mode or who are prone to episodes of reduced cardiac blood flow. Ten years ago, an EPRI study found that some unipolar pacemakers could malfunction in 60 Hz fields above 2 kV/m (see *MWN*, Jun85). The introduction of new designs, including more sensitive dual-chamber models, and of implantable defibrillators prompted EPRI to revisit the EMI question, focusing on potential hazards to utility workers. The report, issued in August, notes that defibrillators can also malfunction in fields above 2 G and warns that an EMI-triggered pulse occurring in the “vulnerable” period in the cardiac cycle could cause “life-threatening” ventricular fibrillation. While cautioning that “no data currently exist” on threshold electric field intensities for EMI in defibrillators, the report suggests that they are likely to be similar to those for pacemakers. To obtain a copy of the 68-page report, *Susceptibility of Implanted Pacemakers and Defibrillators to Interference by Power-Frequency Electric and Magnetic Fields*, contact EPRI's Distribution Center (see p.17).

VIEWS ON THE NEWS

The Price of Ignorance: Hidden Risks and Absent Benefits

It's time to close the book on EMF health concerns—so say the *New England Journal of Medicine*, the American Physical Society and the utility industry.

And recent events have certainly seemed to favor this position. When physicists said there was no need to worry about EMFs, they got widespread and favorable press coverage. Next, PBS' *Frontline* asked if it was not time to shut down EMF research. Then the National Academy of Sciences (NAS) panel minimized the chance of a cancer risk, and the National Cancer Institute said that it had done the definitive study of childhood leukemia and found nothing. EMF lawsuits are on the decline. Three recent animal studies are now also part of the trend (see p.4).

Who in Congress, surveying this landscape, would want to spend another dime on EMFs and public health?

The problem is that the many studies that point to a health risk are still standing. The evidence against EMFs is in fact stronger today than it was in 1990, when EPA experts labeled EMFs "a probable human carcinogen." When one epidemiological study after another finds a relative risk above 1.0, it's hard to dismiss this as an imaginary hazard.

Even the industry-sponsored Electric Power Research Institute (EPRI) has conceded that there is evidence in favor of an EMF-cancer connection. An EPRI meta-analysis of 29 occupational studies found that EMF exposure increased brain tumor risk significantly—by about 20% (see *MWN*, J/F96). EPRI's analysis of 38 studies on leukemia and EMFs at work had similar results (see *MWN*, N/D97).

In this issue we publish a long-suppressed report drafted by the EPA in 1994, which again concluded that EMF exposure probably leads to more cancer (see p.1). Surprisingly, several observers think that EPA's summary of the data is similar to that of the NAS panel (see p.6), which was widely interpreted as saying that EMFs and cancer are unrelated.

The difference is one of perspective. If you are looking for *conclusive proof* that EMFs harm human health, as the NAS panel did, the evidence looks weak. But from a public health viewpoint, the question is whether an increased risk is *likely*—and then the data paint a different picture.

As a participant at the January NIEHS epidemiology review told us, "We are somewhere in the messy middle. The evidence is not strong enough to say that EMFs are definitely harmful, but the data are disconcerting. You cannot say there is nothing there." In short, the evidence for a health risk is strong enough that it would be a mistake to ignore it.

Some will grant that there could be a small risk attached to power line EMFs. But since it is either small or nonexistent, they argue, we should not spend scarce research dollars on EMF health research. There are other, more pressing threats to human health, they say, and the money would be better spent elsewhere.

This argument loses sight of the ubiquity of electricity and electronic technology in modern life. Those concerned about public health cannot afford to be so complacent. Even a small risk, spread over a large population, can have a high social cost.

And the risk may not be so small. It is true that the increases

found in most epidemiological studies have not been large. But if researchers are measuring the wrong kinds of exposures, they will miss the true size of the effect.

Take the case of Agent Orange. A contaminant in Agent Orange, dioxin, is orders of magnitude more toxic than the herbicide itself. And dioxin concentrations vary widely from one batch of Agent Orange to another. So you cannot just study exposure to Agent Orange—you must also look at the levels of dioxin.

The NAS panel recognized "the possibility that some characteristic of the electric or magnetic field is biologically active at environmental strengths." But which characteristic? EMFs are not just one thing. They are a complicated mix of frequencies, modulations and polarizations. At power frequencies, transients and harmonics are part of the mix, and little-studied.

This is also an issue for animal studies. The clean, perfect sine waves of the 60 Hz fields used in the lab are never encountered in the real world. Studying "pure" 60 Hz fields may be a little like studying "uncontaminated" Agent Orange—without the dioxin. If there is a low-level EMF-cancer risk, current animal studies could be "controlling it out."

This distinction might explain the paradox of recent studies of EMFs and melatonin, a hormone thought to be important in fighting cancer. As Dr. John Reif of Colorado State University in Fort Collins noted last year, "Most natural observations appear to find melatonin changes, while controlled lab studies tend not to....I'm concerned that the controlled lab trials may not mimic exposures in the real world" (see *MWN*, M/A97; also N/D97).

We are faced with a knotty problem, and not one that will be solved quickly. But often the hardest problems lead to the biggest breakthroughs.

We pay for our ignorance of bioelectromagnetics in two ways. It is not just the unknown dangers, but also the missed opportunities. We are as much electromagnetic as we are chemical beings and, in principle, EMFs could be used far more widely in the kinds of therapeutic roles played by drugs today. Recent medical research suggests the range of benefits we have been missing: treatments not just for broken bones, but for ailments from migraine headaches to multiple sclerosis to cancer itself.

But to assume that electromagnetic fields, as a class, can only have beneficial effects would be as foolish as to make the same assumption about drugs. We cannot afford to ignore the risks *or* the benefits. For both these reasons, cutbacks in EMF research undermine public health.

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