

INSIDE...

EMF NEWS pp.2-4

Power Line Talk:

AMA and Prudent Avoidance: A Mystery Story • Settlement of Childhood Cancer Case • EMF RAPID Funds Unmatched by Industry • Camas, Washington, Targets 4 mG Exposure Limit

Mothers' Use of Sewing Machines Linked to Childhood Leukemia

NAS-NRC Begins Review of Ecological Effects of Navy's Project ELF

HIGHLIGHTS pp.4-5

NIOSH Recommendations on Police Radar House Cuts EPA's EMF & RF/MW Budget

FDA's Swicord To Head Motorola's Growing Research Program

Table of Motorola Research Projects

COMMENTARY pp.6-10

The Science and Politics of the EMF Puzzle; The Missing Pieces in the "Frontline" Story

SPECIAL REPORT pp.12-15

NCRP Draft Report on EMFs: Conclusions and Recommendations

FROM THE FIELD p.10

Clippings from All Over

UPDATES pp.16-18

Is that a Cellular Phone Tower or a Tree? • Lai-Singh Paper Published • Astronomers Anxious About Cellular Phones • EMF Technical Primer • NIH Peer-Review Panel • People in the News • Proceedings of EM Hypersensitivity Meeting • Call for Papers on RF/MW Effects • Review Paper

CLASSIFIEDS pp.16-20

Draft NCRP Report Seeks Strong Action To Curb EMFs Committee Cites 2 mG Limit as Goal

The National Council on Radiation Protection and Measurements (NCRP) committee charged with evaluating the potential health effects of electromagnetic fields (EMFs) has completed a draft report that calls for strong action to curtail the exposure of the U.S. population. "It took us nine years but we finally reached agreement," committee chair Dr. Ross Adey, of the Veterans Administration Hospital in Loma Linda, CA, told *Microwave News*.

The draft report generally endorses a 2 mG exposure limit. It would take effect immediately for new day care centers, schools and playgrounds, as well as for new transmission lines near existing housing. A somewhat more flexible policy would be applied to new housing and offices.

For existing facilities, the committee recommends a more gradual approach, with stronger restrictions phased in over time if the evidence of a health risk continues to grow.

The report was funded by the Environmental Protection Agency (EPA). Dr. Joe Elder, EPA's program officer for the NCRP study in Research Triangle Park, NC, called the committee's report "the first comprehensive review of the world's literature on EMF health effects."

In sharp contrast to the NCRP report's conclusions, public television's "Frontline" sees no need for even a policy of prudent avoidance; see Commentary pp.6-10.

The EPA will release its own review this fall, limited to an analysis of the cancer risk. Dr. Robert McGaughy, the chief author of the EPA review, who has read the NCRP draft, said that, on the question of cancer, the two drafts "appear to be heading in the same direction."

Copies of the report's conclusions and recommendations (see pp.12-15) have already been widely circulated. In a letter to *Microwave News*, Dr. Charles Meinhold, the president of the NCRP, emphasized that the draft report is an internal document and that it has "no standing at this time."

"It's unfortunate that the report has been leaked," said Dr. Richard Lovely of the Battelle Pacific Northwest Labs (PNL) in Seattle, a member of the committee. "There is a process by which this document should have been reviewed and that process has been seriously compromised."

The 800-page draft will now undergo the NCRP review process. First a half-dozen "critical reviewers" will go over it and recommend changes, according to Dr. Constantine Maletskos, NCRP's liaison for the report. After the necessary revisions are made, it will be sent to the 75 members of the council. "We are aiming to complete it later this year," Maletskos said, "but that's unlikely." He predicted that the final report would be publicly available in the first half of 1996.

(continued on p.11)

« Power Line Talk »

The **American Medical Association** (AMA) doesn't believe in prudent avoidance any more—or does it? The AMA appeared to abandon its support for prudent avoidance in December 1994, but today no one can say exactly why. In mid-1994, the AMA's Council on Scientific Affairs (CSA) approved a report on EMFs containing the following recommendation:

That the AMA urge manufacturers, home-builders, and employers to begin planning to reduce the exposures of workers and the public to electromagnetic fields, including those from power lines, appliances and equipment. The focus should be on strategies and techniques that are cost-neutral, or will not greatly increase costs.

This was not a new stand for the AMA, which in a 1990 report held that “prudent measures should be taken to reduce people's EMF exposures.” But by the time the new report emerged from the AMA's House of Delegates in December 1994 (see *MWN*, J/F95), this recommendation had been deleted. Dr. **Douglas Skelton**, former chair of the CSA, confirmed in an interview that the CSA had approved the recommendation, as worded above, prior to the December House of Delegates meeting. Skelton added that this language was softer than in the staff's initial draft: “We felt the staff had too strongly urged expenditures to reduce exposures that might not be a very efficient use of resources. We'd support prudent and *economic* efforts to reduce exposures—but not putting demands on people to spend millions of dollars. That was the line we were trying to draw.” When asked how the support for prudent avoidance came to be removed entirely, Skelton said, “I don't right now have any idea how that came about.” In fact, the change was made by Reference Committee E, one of several working committees that hear testimony and report to the House of Delegates. Reference Committee E's report urged the House of Delegates to delete the recommendation on prudent avoidance, explaining that in testimony before the committee, “a general consensus was expressed that recommending specific ‘preventive measures’ when no health risks have been demonstrated might be premature and inconsistent.” Who gave this testimony, which changed the policy of the AMA? The chair of Reference Committee E, Dr. **Richard Tompkins** of the Mayo Clinic in Rochester, MN, told *Microwave News* this July that he did not remember the name of a single person who had spoken, and that he did not think there was any way to find out. The committee's secretary, Dr. **Sona Kalousdian**, confirmed that there was no record of who had testified and also said that she did not remember. Dr. Tompkins said there was no discussion among the members of Reference Committee E about the fact that this represented a change in AMA policy. The committee's report said that “the CSA concurred with the proposed changes.” However, Dr. **Theodore Doege**, who first drafted the report for the CSA, said that he did not learn of the change until two weeks after the December meeting of the House of Delegates. Even then, he told *Microwave News*, the rationale was not explained: “I thought it was fine the way it stood, and saw no reason at the time to change anything.” Before being approved by the CSA, the report was reviewed by

Drs. **David Brill**, **Jeffrey Greenawalt**, **John Peters** and **Thomas Tenforde**, with Tenforde as the major reviewer. But Doege said that none of their comments addressed the issue of prudent avoidance. Asked why Reference Committee E deleted this recommendation, Doege said, “I really don't know.”

«« « »»

Massachusetts Electric, a subsidiary of New England Electric System, has agreed to an out-of-court financial settlement to avoid a lawsuit by the family of a child stricken with leukemia. **Scot David** and his wife reached the settlement after their son contracted acute myeloid leukemia (AML), which is unusual in children. According to a report by a Wayland, MA, consultant, magnetic fields inside the front bedroom of the Davids' home reached as high as 37 mG (they have since moved). The report attributes this strong field mainly to the way the house was connected to the power distribution system. Also involved in the settlement was the case of the child's cousin, who regularly slept near the Davids' son and developed idiopathic thrombocytopenia, a deficiency of platelets with no known cause. Attorney Michael Matchen of **Dangel & Fine** in Boston said that no lawsuit was ever filed, and that beyond that he could not “confirm or deny” anything. Susan Stevens, a spokesperson for Mass. Electric, said, “It's the company's long-standing policy not to comment on matters like this.”

«« « »»

With fiscal year 1995 (FY95) almost over, industry contributions to the national EMF research program, known as **RAPID**, have barely passed the halfway mark. The federal government has given \$8 million, which is supposed to be matched dollar-for-dollar with industry funds. At the end of July, the nonfederal contributions totaled \$4.3 million. **Rick Loughery** of the **Edison Electric Institute** in Washington said that, “I am confident that the electric utility industry and the **National Electrical Manufacturers Association** will reach roughly \$5.7 million” by September 30, the end of FY95. The balance must come from non-utility sources, he said, adding that, “The health of the program is of interest to us, but we cannot make a further contribution for FY95 at this time.” The utility industry is maintaining that it is only responsible for two-thirds of the nonfederal funds (see *MWN*, N/D93). The DOE has waged “a pretty intensive campaign” to solicit funds from other sources but so far without success, according to **Lynne Gillette**, DOE program manager for the RAPID program. Gillette said that the DOE has targeted 18 associations that should have an interest in EMFs. Six of the groups have said that they would not be contributing, including the **American Electronics Association**, the **Electromagnetic Energy Association** and the **Association of Home Appliance Manufacturers**. “We are still talking to the other 12,” she said.

«« « »»

The **Camas, WA, City Council** has set 4 mG as the target for maximum EMF exposures permitted for new transmission facili-

ties. The ceiling was established as one of several restrictions in a new ordinance which was approved 5-2 on July 10 in response to constituents' concerns about EMF health effects and property devaluation. Camas, a suburban community across the Columbia River from Portland, OR, is also requiring utilities to use prudent avoidance measures in constructing new transmission facilities and has established setbacks for new power lines near schools, churches, day care centers and playgrounds. It also has banned overhead power lines in residential areas. Violators may be fined or imprisoned. "I believe a lot of communities are looking into similar regulations," said Gwen Hahn, the Camas council member who proposed the restrictions. The ordinance grew out of a moratorium, approved in December 1994, imposed because of concerns that new power lines would be built on a right-of-way owned by Portland-based **PacifiCorp.**, which is working with **Clark Public Utilities**, headquartered in Vancouver, WA, to provide power for the area. The moratorium was in effect until the ordinance was approved. "We did not oppose the ordinance. We did not endorse it. We have some concerns that we may not be able to serve future growth in that

area, but that's something we will address as time goes on," said Mike Shutt, a spokesperson for Clark Public Utilities. David Kvamme, a PacifiCorp. spokesperson, added, "Currently we have no plans to build, although we wanted to keep our options open." **Cindy Sage** of Sage Associates in Montecito, CA, who advised an *ad hoc* council committee studying the issue, supports the ordinance and sees it as "very mainstream." The 4 mG target was actually a compromise, she said. The proposed limit initially was 1 mG. As for the ordinance's overall effect, Sage said, "We all know that the utilities are worried about a patchwork of local regulations. I would expect this to set a precedent and give other communities the political will to establish good EMF land-planning principles in spite of utility opposition." Another community not far from Camas is also taking action to control power lines. On May 16, **Umatilla, OR**, in the northeastern part of the state, imposed a 90-day moratorium on new power line construction and is now reviewing a local utility's application for construction of two transmission lines that would pass through the city. "Our community is inundated with power lines," said Umatilla Administrator Bonnie Parker.

Mothers' Use of Sewing Machines Linked to Children's Leukemia

A McGill University professor believes that EMFs may have been a factor in an observed up-to-sevenfold increase in leukemia among children whose mothers used sewing machines during pregnancy. Her hypothesis follows a 1994 joint U.S.-Finnish report that showed a strong association between EMF exposures on the job and Alzheimer's disease among sewing machine operators and others.

Dr. Claire Infante-Rivard, a professor in McGill University's Department of Occupational Health in Montreal, Canada, said that it was Dr. Eugene Sobel's paper linking EMFs to Alzheimer's disease (see *MWN*, J/A94) that prompted her to consider the possible role of EMFs in her 1991 study of leukemia among children in Spain.

Infante-Rivard had studied 128 cases of acute lymphoblastic leukemia in children less than 15 years old. She found the highest risk for children of mothers working at home during pregnancy, most of whom sewed cotton, wool and synthetic fibers. In her original paper, published in the *Journal of Epidemiology and Community Health* (45, pp.11-15, 1991), Infante-Rivard and her colleagues suggested that exposure to organic dust and synthetic fibers could be responsible for the excess risk.

"Our findings...could be reinterpreted as being EMF-related," Infante-Rivard wrote in a letter appearing in the July 15, 1995, issue of *The Lancet*. "Given the ergonomic features of work on sewing machines, fetal exposure is likely. Of course, continued exposure throughout childhood is also possible."

"We should look at this issue more closely. It might make a lot of sense," Infante-Rivard told *Microwave News*.

Sobel reported a "consistent" pattern of increased incidence of Alzheimer's among workers with "medium" and "high" EMF exposures in three different data sets—two Finnish and one American. Dressmakers and sewers were overrepresented

among the cases in the study. Subsequent surveys showed that EMFs at the operators' heads were 2.7-5.2 mG for home sewing machines and 2-11 mG for industrial units, according to Dr. Joseph Bowman of the National Institute for Occupational Safety and Health, who worked on the study. The levels were about 200 mG at knee level, he said.

Infante-Rivard said that most of the women in her study used home sewing machines, not industrial models, but used them extensively.

Sobel, of the University of Southern California School of Medicine in Los Angeles, told *Microwave News* that his paper on the Alzheimer's-EMF link will appear in the September 1 issue of the *American Journal of Epidemiology*.

The McGill study supports an earlier report by Dr. David Savitz and colleagues at the University of North Carolina, Chapel Hill (see *MWN*, M/J90). In the Savitz study, children whose mothers used electric blankets during pregnancy were found to have higher risks of leukemia and brain tumors. Savitz reported that the incidence of brain tumors among the offspring had increased 250%. There was a 70% increase for leukemia and a 30% increase for all cancers. "Our findings for prenatal exposures to electric blankets are directly relevant to Infante-Rivard's observations," Savitz told *Microwave News*.

NAS-NRC Committee Reviews Navy's Project ELF Studies

The National Academy of Sciences' National Research Council (NAS-NRC) has formed a committee to evaluate studies that monitored the effects of EMFs from Project ELF. The controversial Navy system, which transmits 72-80 Hz signals to communicate with submerged submarines, uses a 56-mile-long antenna system in Michigan and one half as long in Wisconsin.

The Navy commissioned the NRC last fall to analyze 11 studies on the biological and ecological effects in the forests

around the antennas (research on soil amoebae is not completed). The 11-member committee met for the first time July 6-7.

“Our job is not to summarize but to critically assess the studies,” said Raymond Wassel, an NRC program director working with the committee. Wassel said the group would write a report, expected by May 1996, that will review the objectives and design of the monitoring program, as well as data collection methods, analyses and interpretations.

The chair of the committee is Dr. Duncan Patten of Arizona State University, Tempe. The other members are: Drs. Om Gandhi, University of Utah, Salt Lake City; Thomas Getty, Michigan State University, Hickory Corners; William Gordon, Rice University, Houston; Woodland Hastings, Harvard University, Cambridge, MA; Peter Karieva, University of Washington, Seattle; James Lin, University of Illinois, Chicago; Robert Olsen, Washington State University, Pullman; John Pastor, University of Minnesota, Duluth; Beverly Rathcke, University of Michigan, Ann Arbor; and Antonio Sastre, AS Consulting and Research Inc., Suffern, NY.

Hastings served as the chair of a 1977 NAS study on the potential effects of ELF fields. One of the concerns at that time was whether the ELF antenna would have a serious effect on nearby vegetation and “in an extreme...cause a ‘wasteland’ throughout an area of several square miles.” But the study

concluded, in part, that available data on EMF effects on plants, though meager, indicated that there would not be any effect on vegetation growing near the antenna.

Hastings’s participation with the 1977 review group is “one of the reasons he is on the NRC committee,” said Bonnie Scarborough, an NRC research assistant working with Wassel.

The ELF communications system was built in the 1980s after years of dispute over its safety. Originally known as Project Sanguine (later Seafarer), the system, as proposed in the mid-1970s, would have used 6,000 miles of antennas. The target of a lawsuit, Project Sanguine/Seafarer was later scaled back. The 1977 NAS study recommended that a monitoring program be initiated if the system was ever built. In 1982, shortly after the Michigan site had begun initial operations, a monitoring program was started at both sites. The program has been managed by the IIT Research Institute (IITRI) in Chicago (see *MWN*, My81, J/A83, J/F84, Mr84, J/A84, My85 and J/F90).

One of the monitoring studies already has gained some publicity. Scientists at Michigan Technological University’s School of Forestry and Wood Products in Houghton monitored vegetation in the region from 1985 to 1994. They recorded enhanced growth—as high as 74%—in some red maples. The increases occurred at magnetic field levels of 1-7 mG among trees growing within 50-150 meters of the antenna (see *MWN*, J/F95).

HIGHLIGHTS

NIOSH Urges Caution on Police Radar Use—But No Epi Study

The National Institute for Occupational Safety and Health (NIOSH) is calling for police radar to be used in ways that would “virtually eliminate” officers’ exposure to microwave radiation. The recommendations are contained in a feasibility study that argues against attempting an epidemiological study of cancer among police officers who have used radar.

The NIOSH report, *Occupational Exposure of Police Officers to Microwave Radiation from Traffic Radar Devices*, does call for a broader study of health problems of police officers, which might lay the basis for a later examination of police radar. But funding of such research does not seem likely.

“It’s not what we had hoped for,” Gary Poynter, research officer of the National Fraternal Order of Police in Cincinnati, told *Microwave News*. “We wanted a recommendation for an epi study and some stronger recommendations for antenna use.” Still, he said, “It’s definitely a step forward.”

NIOSH describes its recommendations on radar antennas as “prudent public health practice even in the absence of an identified health risk.” It suggests that hand-held radar guns have a “dead-man switch”—in which the radar beam shuts off when it is not gripped by the user’s hand—to avoid accidental exposure. As for two-piece radar units, the study states that antennas should be mounted so that they do not point at police officers inside the car, and that “the preferred mounting location would be outside the vehicle altogether.”

Poynter found this guidance too weak: “We thought it should

require that all antennas be placed outside the vehicle.” On radar guns, Poynter said, “My recommendation is, if it doesn’t have a dead-man switch, don’t use it.”

Dr. Gregory Lotz, chief of NIOSH’s Physical Agents Effects Branch in Cincinnati and one of the report’s authors, responded that, “A lot of small police departments don’t have the resources to modify existing radar guns. If they take precautions, they can keep exposure to a minimum.”

Lotz and his coauthors conclude that “conducting a definitive epidemiological study of health risks associated with traffic radar devices does not seem feasible at this time.” They explain that the low incidence rate of the relevant cancers would require

EPA’s EMR Programs Face Budget Ax

The House Appropriations Committee wants to cut the Environmental Protection Agency’s (EPA) “low-priority radiation programs” from the agency’s fiscal year 1996 (FY96) budget. This would eliminate EPA’s EMF and RF/MW programs, according to Dennis O’Connor, EMF team leader at EPA headquarters in Washington.

Among the many budget cuts specified in the committee’s report is \$11,876,000 for radiation programs “involving criteria, standards, guidelines, program implementation and environmental impact assessments.” The committee is trying to reduce the overall EPA FY96 budget to \$4.9 billion, 34% less than President Clinton’s request for \$7.3 billion. The Senate will make its own recommendations when it returns from its recess in mid-August.

a large population of radar-exposed officers, combining those from several states. However, they found "that law enforcement agencies do not record traffic radar use in any systematic manner." Lotz told *Microwave News* that, "We have some genuine scientific concerns about whether we could come up with anything other than an equivocal result."

NIOSH's feasibility study is its response to a three-year-old congressional request, coming after hearings on police radar and cancer chaired by Sen. Joseph Lieberman (D-CT) (see *MWN*, S/O92). This July, Sen. Lieberman told *Microwave News* that while he was "disappointed" that NIOSH decided against an epidemiological study, he was "pleased that they nonetheless chose to make specific, practical recommendations" to limit exposure.

In late 1992, the then-head of NIOSH, Dr. Donald Millar, wrote to Lieberman, pledging, "We will [also] attempt to identify other occupational groups whose exposures to radar may be higher or better quantified. It is possible that such a group may provide the opportunity for a more precise epidemiologic evaluation of the biologic effects of radar."

This point is not addressed in the feasibility study. The report does note, however, that "there is very little epidemiologic data on the effects of RF/MW radiation on humans." Lotz added that, "There is a need for epi studies of people who may be microwave-exposed."

"I plan to follow up with NIOSH," Lieberman said, expressing hope that the agency would follow through on a study of other radar-exposed workers.

The NIOSH report does call for a broader study of occupational health risks for police officers, involving between 10,000 and 30,000 officers at a total cost of \$1.4-2.6 million. Lotz said that this could lead to a follow-up investigation of radar use, but "would have value for the occupational health of police officers whether or not we could clarify the radar question."

Two studies involving police radar are now under way in Canada. Dr. Maurice Bitran of the Ontario Ministry of Labor said that the ministry is doing research along these lines, first looking at the overall health of police and later investigating radar exposure. The second study, coordinated by Ottawa Civic Hospital and the Canadian Police Research Center, is an initial investigation of radar use and illness among members of the Royal Canadian Mounted Police. Dr. George Wells of Civic Hospital said that the results will determine whether they move on to a full-scale epidemiological survey.

In the U.S., prospects appear dim for funding a general study of police health issues. The Clinton Administration's budget request for fiscal year 1996 does not include funding for such research, while the House of Representatives is seeking a 25% cut in NIOSH funding and the eventual elimination of the agency.

FDA's Swicord To Run EMR Research Program at Motorola

After 26 years at the Food and Drug Administration (FDA), Dr. Mays Swicord is leaving to become the director of Motorola's electromagnetic radiation (EMR) biological effects research program. Swicord will join Motorola on October 1 and will report to Dr. Quirino Balzano, a corporate vice president.

"The appointment of Dr. Swicord to our research team testifies to Motorola's ongoing commitment to bring the best possible science and scientists to bear on the issues related to the safety of our products," Balzano told *Microwave News*.

Swicord, chief of FDA's radiation biology branch, has led the agency's efforts to monitor the safety of cellular phones.

"Appropriate steps will be taken by the FDA to make sure that the agency will continue its electromagnetic radiation programs," he said in an interview.

Motorola's research program, which focuses on cellular phones and other wireless technology, is made up of at least seven major projects that are now under way (see table below). In addition, the company sponsors other research through its membership in the Cellular Telecommunications Industry Association and in Germany's Research Association for Radio Applications (FGF).

Norman Sandler, a Motorola spokesperson, said the seven ongoing projects are those "we are in a position to acknowledge at this time with the consent of the principal investigators." He stressed that, "Our policy is to have *all* Motorola-sponsored research published in open, peer-reviewed literature upon completion."

Motorola's Ongoing Cellular Phone Health Studies

Principal Investigator	Location	Signal*	Type	Due Date
Dr. Ross Adey	VA Medical Center, Loma Linda, CA, U.S.	TDMA	Animals & Cells	1996
Professor Konstantin Hossman	Max Planck Institute, Cologne, Germany	GSM	Animals	1995
Professor Marika Kiessling	University of Heidelberg, Heidelberg, Germany	GSM	Animals	1995
Professor Niels Kuster	ETH, Zurich, Switzerland	GSM	Dosimetry	Open-Ended
Dr. Robert Morgan	Environmental Health Strategies, Redwood City, CA, U.S.	—	Epidemiology	Not Available
Dr. Joseph Roti Roti	Washington University, St. Louis, MO, U.S.	CDMA	Animals & Cells	1996
Dr. Bernard Zook	George Washington University, Washington, DC, U.S.	MIRS	Animals	1996

*CDMA = Code Division Multiple Access; GSM = Global System for Mobile Communications; MIRS = Motorola Integrated Radio Services; TDMA = Time Division Multiple Access.

COMMENTARY

Commentary from the Bioelectromagnetics Society Annual Meeting

The Science and Politics of the EMF Puzzle; The Missing Pieces in the “Frontline” Story

The irony is astonishing. On the very day that a committee of the National Council on Radiation Protection and Measurements (NCRP) completed its 800-page draft report asking regulatory agencies to pay “serious attention” to EMFs, public television station WGBH aired a one-hour show across the country comparing EMFs to cold fusion. While the NCRP committee called for “a national commitment to further research,” the June 13 *Frontline*, “Currents of Fear,” asked whether it was time to close down the research effort.

Of course, *Frontline* dominated the gossip circles at the annual meeting of the Bioelectromagnetics Society (BEMS) held later that same week in Boston, WGBH’s hometown. Only a few insiders knew about the NCRP report.

It’s too bad that Jon Palfreman, WGBH’s producer of this show, did not bother to go across town to attend the BEMS meeting. If he had listened to some of the presentations and talked to members of the NCRP committee, he might have realized that his documentary for the *Frontline* series left out key facts—facts that conflict with his thesis that concern over EMF health effects has no scientific basis.

Then again, it might not have made a difference. There are good reasons to think that Palfreman never approached the EMF puzzle with an open mind. Much like Gary Taubes, whose own attack on EMFs appeared in last November’s *Atlantic Monthly*, Palfreman started with an *idée fixe* and then went looking for like-minded people.

In a nutshell, Palfreman’s thesis is that the animal studies show no effects, the cellular experiments are irreproducible, the best epidemiological evidence is specious and the postulated biophysical mechanisms of interaction contradict the laws of physics. Unfortunately, it isn’t quite that simple.

* * *

Let’s begin with what Palfreman left out:

Animal Studies

Palfreman only cited those experiments being carried out at Chicago’s IIT Research Institute (IITRI) by Dr. David McCormick, whose first cancer study failed to show any effect. McCormick’s results are so new that they have not yet been peer-reviewed or published. Even so, they already have their share of critics, who have raised questions about the study design.

Palfreman built up IITRI’s exposure study as the definitive, best-controlled experiment ever. He let Dr. Gary Boorman of the National Institute of Environmental Health Sciences (NIEHS) make the case:

As you refine your studies, if there really is an effect, the effect should increase, it should become stronger, it should become more focused, and if you cannot, with repeated studies and with better studies, you continue not to find an effect or find only marginal effects, then it becomes obvious that there’s really nothing there.

Boorman’s scientific logic is of course rational and correct, but, in this particular context, it makes no sense. Very few animal cancer studies have been done to date and McCormick has only completed a *single* experiment. It’s hard to make a case for a trend with IITRI’s one data point.

In a press release posted on the Internet, the WGBH public affairs office lost all control of the facts:

Dozens of animal experiments have been carried out in which rats and mice are exposed to very large magnetic fields for long periods—some for their entire lives—but no animal has ever been proven to contract cancer due to this exposure.

If you add up all the animal–cancer studies ever done, you do not reach “dozens” and some of those that have been done show some adverse effects. What did Palfreman say when asked about this? Only that he did not write the press release. No apologies, no excuses, no interest in setting the record straight.

At BEMS, both Dr. Craig Byus¹ of the University of California, Riverside, and a Finnish team² reported seeing higher-than-expected rates of cancer in animals exposed to EMFs. For one set of exposures, Byus said that he found a “very, very significant” increase in tumor incidence. Byus’s study is being sponsored by the NIEHS, where Boorman works.

But the most riveting talk on animal experiments was that given by Dr. Wolfgang Löscher of the School of Veterinary Medicine in Hannover, Germany. He and Dr. Meike Mevissen have completed a *series* of studies at four different exposure levels—much of which has already been published in respected peer-reviewed journals.³ In Boston, Löscher concluded that the magnetic field “promotes the growth and increases the incidence of tumors in a dose-dependent fashion.”

Boorman said that he is impressed by Löscher’s animal studies not only because they show clear and reproducible effects but because Löscher also has confirming experimental evidence on the hormone melatonin and the growth enzyme ODC. It all adds up to a consistent and solid picture of EMF effects on a living organism.

Indeed, Boorman is so impressed with Löscher’s work that he recently issued a request for proposals to repeat the animal studies at a cost well in excess of \$1 million. Does this sound

MICROWAVE NEWS is published bimonthly. • ISSN 0275-6595 • PO Box 1799, Grand Central Station, New York, NY 10163 • (212) 517-2800; Fax: (212) 734-0316 • Editor and Publisher: Louis Slesin, PhD; Senior Editors: Peter Hogness, Gail Roberts; Associate Editor: Christopher Doherty; Copy Editors: Jim Feldman, Roy Thomas Jr.; Production Coordinator: Joe Mungioli; Circulation Assistant: Diana Cooper; Intern: Malachi Bergson • Subscriptions: \$285.00 per year (\$315.00 Canada & Foreign, U.S. funds only); single copies: \$50.00 • Copyright © 1995 by Louis Slesin • Reproduction in any form is forbidden without written permission.

like a scientist who thinks that there is “nothing there,” as Palfreman would have us believe? The Department of Energy (DOE) is so favorably impressed by Löscher that it will sponsor his work directly—one of the very few times the DOE has ever funded EMF research outside the U.S.

“The animal studies were incompletely and too simply presented” on *Frontline*, Boorman said in an interview. If Palfreman had used Löscher’s studies as his example instead of IITRI’s, he said, the audience would have reached a “very different conclusion.”

Cellular Studies

Here again, Palfreman based his argument on one study—Battelle’s Dr. Jeffrey Saffer’s unsuccessful attempts to repeat Drs. Reba Goodman and Ann Henderson’s experiments showing changes in gene expression in HL-60 cells. At this point, no one knows why the two (three, counting a British team that also found no response) labs got different results. But looking beyond this particular experiment, another picture emerges.

A number of researchers have shown that EMFs can affect gene expression. Among them is Saffer himself. At last November’s EMF review in Albuquerque, NM, Saffer reported that he had turned his attention to another cell line, JB6, and found preliminary evidence of a response.⁴ Saffer later parlayed that finding into a research grant of more than \$1 million from the NIEHS.

As it turns out, at BEMS, Saffer said that so far he has been unable to reproduce the effect.⁵ Nevertheless, another lab, at the Food and Drug Administration, has been seeing a robust response in JB6 cells.⁶

When asked about the JB6 work, Palfreman said that he knew nothing about it and that Saffer had never mentioned it. Saffer must have gone through a TV interview—never a short affair—without a word about his new million-dollar project on gene expression.

One of the best-known scientists at the BEMS meeting was struck by this omission: “If Saffer does not think there is anything there and doesn’t have the scientific imagination to know where to look, why doesn’t he give the money back?” he asked, expressing his own frustration on how hard research money is to find.

Epidemiological Studies

Most of the data supporting a cancer risk comes from studies of human populations, and many leading epidemiologists—including Drs. Anders Ahlbom, Birgitta Floderus, Sam Milham and Gilles Thériault—have found strong evidence for a link. They are all internationally known and respected and each has led large EMF studies.

Palfreman is unconvinced. He says that “most epidemiologists” regard the EMF field “as something of an embarrassment to their profession,” but does not cite any sources. If he were right, why couldn’t he find a single epidemiologist other than a longtime utility consultant to say this to the camera? And why are so many epidemiologists still working on the EMF puzzle if it so stigmatizes them?

Palfreman’s experts on epidemiology were two electric

utility consultants: Dr. John Moulder of the Medical College of Wisconsin in Milwaukee, an expert on using radiation to treat cancer, and, to a lesser extent, Dr. Patricia Buffler, an epidemiologist at the University of California, Berkeley. He used them to disparage the Swedish childhood cancer study by Drs. Maria Feychting and Anders Ahlbom. Moulder said that the Swedes made a fundamental error: They made so many comparisons that, by chance alone, they had to come up with some positive associations. Buffler agreed. The Swedish study, they argued, was simply an exercise in data dredging.

Ahlbom dismissed Moulder’s and Buffler’s criticisms. “It is absolutely necessary to look at a large number of analyses in any epidemiological study to look for consistencies and inconsistencies in the data,” he said in an interview.

In a review⁷ published earlier this year, Feychting and Ahlbom concluded, “The evidence on leukemia in children appears rather consistent.” They went on to say that the hypothesis that EMFs led to the development of cancer cannot yet be considered proven and that we “have to accept the uncertainty.”

The *Frontline* interview with Dr. David Savitz made it clear that Palfreman is not interested in uncertainties. After talking to Savitz for more than an hour on camera, Palfreman only gave him some 20-30 seconds of airtime—and even then Savitz never got to say a word about epidemiology, only exposure assessment. Savitz thinks he knows why he was not allowed to say more: “Palfreman had his point of view and looked for quotes to support it,” he said in an interview.

The data-dredging argument is “completely unsatisfying—it’s no explanation at all,” Savitz said, adding that, “It is a strength of the study to have investigated so many possibilities.” As Ahlbom pointed out, “Suppose that we had not done this, but had been asked to do so after publication, should we have answered: ‘This is an interesting question, but unfortunately we cannot do this because it is not in the study protocol?’”

The contribution of the Swedish study is not that it gave a definitive answer, but that it provided a new and persuasive piece of the EMF puzzle that fits neatly into the existing mosaic. But Palfreman has no patience for anything short of absolute proof.

The earlier Wertheimer-Leeper, Savitz and London-Peters studies all showed a link between childhood cancer and EMF exposures, as defined by the Wertheimer-Leeper wire codes. When measured fields were used, however, the link was weaker. Some observers, especially those from the utility industry, jumped on this apparent discrepancy and dismissed the studies as being internally inconsistent.

Using historical records of the current loads on Sweden’s power lines, Feychting and Ahlbom calculated the magnetic fields when a child got sick—as well as one, five and ten years prior to diagnosis. (This partly explains why they made so many comparisons, which led to the charges of data dredging.) The Swedes found that the calculated historical fields did show a link to cancer. Making their case even stronger, they found a dose-response relationship. Further, like their predecessors, Feychting and Ahlbom did not see an association between present-day magnetic fields and leukemia. This suggested, as many epidemiologists had long speculated, that wire codes

are good indicators of long-term EMF exposures.

In short, the Swedes set out to see whether there was a link between power line magnetic fields and leukemia and that is exactly what they found. They improved on past studies and the link grew stronger: precisely the type of evidence that skeptics say they want to see. Feychting and Ahlbom did not answer all the questions, but epidemiology never does.

Biophysical Mechanisms of Interaction

This is the most important part of Palfreman's argument. Whether an experiment shows an EMF effect in humans, animals or cells becomes moot if it is possible to show that such interactions are theoretically impossible: Yale University physicists Drs. Robert Adair and William Bennett believe this, and, it appears, so does Palfreman. To use the metaphor conjured up by Adair on *Frontline*, worrying about EMF health effects is akin to being concerned that a cat will damage a tree by breathing on it during a howling wind storm.

Given the recent statement⁸ by the American Physical Society (APS) that EMFs are of no concern—also cited by Palfreman on the show—one might conclude that all physicists agree with Adair and Bennett. But that would be a mistake.

There are many physicists working in the field of bioelectromagnetics. As Dr. Bill Kaune, a consultant based in Richland, WA, who has a doctorate in physics, put it: "We physicists who do research on EMFs have long been aware of the signal-to-noise problem, but, regardless of our concerns, experiments seem to show that EMFs affect living tissues. I don't see how one can justify flatly discounting the work of a large number of epidemiologists and laboratory biologists solely on the basis of signal-to-noise calculations on highly simplified models of living tissues."

A couple of years ago, Adair had the opportunity to make his case to the JASONs, a high-level group of physicists, whose advice is routinely sought by the Department of Defense. In his report on behalf of the JASONs, Dr. Steven Koonin of Caltech concluded: "The essential point to take away...is that a cellular-level coupling of magnetic fields to biological systems is physically plausible and does *not violate any physical principles.*"⁹

Koonin was a member of the APS council that approved the statement, and may well believe that "no plausible biophysical mechanisms" have been identified. But this does not mean, as Adair and Bennett (and Palfreman) contend, that such interactions are impossible.

As for the APS statement itself, it is as much a political as a scientific document. A look at Dr. David Hafemeister's slipshod background paper¹⁰ that served as the basis for the statement is convincing evidence of his and the APS' political agenda. Hafemeister is well attuned to the world of politics and the power of a press release given to a responsive reporter, having spent many years in Washington working for the federal government and congressional committees.

Adair was at the BEMS meeting, and when asked how he could explain an organism's ability to sense magnetic fields as weak as 0.2 mG against the background of the earth's 500 mG field, Adair replied: perhaps if you have enough cats and

enough trees....

Or to put it another way, biological systems are complex and are not easily captured by a simple model or a colorful analogy.

Implicit in these discussions is that when we talk about EMFs we are referring to one physical phenomenon. In fact, there are a huge variety of EMFs, each of which may have a different effect. Among the most intriguing are transients—short intense pulses of energy.

At BEMS, Dr. Antonio Sastre, a consultant based in Suffern, NY, and his colleagues showed that when it comes to EMF transients—common occurrences on power lines—the signal can rise above the background noise.¹¹ "The objection that environmental fields are too weak with respect to thermal noise need not apply to transients," Sastre said in an interview, pointing out that one needs to invoke only "pedestrian physics applied to realistic models of cells" to show this. Sastre's work is sponsored by the Electric Power Research Institute (EPRI).

Sastre's work on transients follows last fall's announcement by Thériault that he and his colleagues at McGill University in Montreal, Canada, had found a very strong association between exposure to transients and lung cancer among utility workers. Hydro-Québec's first reaction on learning of this result was to take the data away from the McGill research group.¹² Seven months later, the conflict remains unresolved and Thériault's team is still barred from probing further into this risk—one of the largest ever observed for any EMF-exposed population.

* * *

Palfreman is a serious journalist. He has won two AAAS science writing prizes, as he is not too bashful to tell his critics. But he clearly came to EMFs with his mind made up. He might have salvaged the show had he taken the trouble to talk to those whose work he is disputing.

Palfreman never interviewed Drs. Anders Ahlbom or Reba Goodman, two of the scientists he skewered on the program. He said that he exchanged faxes with Ahlbom and has the faxes to prove it. This made no impression on Ahlbom, who cannot remember Palfreman among the many reporters who have called him.

The Goodman story is different and more troubling. Palfreman said that Goodman refused to be interviewed, while Goodman maintained that no one from *Frontline* ever called her. Goodman is right. Palfreman let one of his assistants, Michaela Barnes, contact Goodman, but she conceded that she never did. When asked why not, Barnes cited "political reasons."

One set of *Frontline* interviews, left on the cutting room floor, involved the controversy over health problems among those living next to an electrical substation in Guilford, CT. Paul Brodeur used this as a case study in a 1990 article published in *The New Yorker*,¹³ with Bob Hemstock serving as the protagonist. In the course of his interview with *Frontline*, Hemstock offered to contact Goodman on the program's behalf, since he was going to be talking to Goodman about a project of his own.

Goodman told Hemstock that it would not be a good idea for him to visit her lab with a television crew. Goodman was swayed, at least in part, by Hemstock's theories on EMFs, which

Commentary: Missing Pieces of the EMF Puzzle

are somewhat idiosyncratic. In any case, by the time Hemstock relayed this message to Barnes, he had himself decided, for his own reasons, that he did not want to take the *Frontline* crew to Goodman's lab.

Hemstock never knew and therefore could not tell Goodman about *Frontline's* interest in Saffer's experiment. Nor did Goodman know that the public television crew Hemstock mentioned was from *Frontline*.

No one from *Frontline* ever called Goodman directly—even though Palfreman planned to tell the world that her results are worthless. Neither Palfreman nor anyone else from *Frontline* was interested in hearing Goodman's side of the gene expression story—a violation of one of the most basic rules of journalism. The omission is striking given Palfreman's statement that he is “interested in finding the truth in a world where, increasingly, scientific data is being abused and distorted for political ends.”

* * *

One of the most revealing aspects of the *Frontline* episode is that so few members of the bioelectromagnetics community have spoken out to correct the obvious errors in the program. Palfreman said that the vast majority—approximately 95%—of the comments have been favorable. The reason for the silence is an important part of the EMF story.

EMF research is an underfunded backwater of the scientific community. Before the congressionally mandated \$65 million RAPID program got under way last year, most of the available research funds came from the electric utility industry through EPRI and from the DOE, an agency not known for putting radiation safety ahead of its other program objectives. EPRI and the DOE do not look kindly on those who publicly highlight possible health risks.

This is the grubby side of science, where many researchers are as interested in securing contracts and grants—even if it means making compromises along the way—as they are in doing the actual scientific work.

This also explains why there has been no outcry—indeed we have yet to hear a single word of public protest—at Hydro-Québec's outrageous behavior in blocking Thériault's access to millions of dollars worth of data that could explain part of the EMF puzzle.

Among the possible casualties of this silence are the emerging biomedical applications of EMFs, for instance the use of pulsed EMFs to heal nonunion fractures. If low-level, non-thermal effects fall into disrepute, then, by definition, such medical devices are ineffective and should not be on the market. But even those who see a bright future for EMF therapies are not speaking up.

Before the New York Power Lines Project began in the early 1980s, neither EPRI nor the DOE moved to confirm or refute the Wertheimer-Leeper cancer study. As a result, it took nine years to repeat it. And as soon as Savitz had done so, EPRI, still unconvinced, decided that it had to be done all over again. This took another five years. Critics of the Feychting-Ahlbom study should not wonder why we don't know more, but rather should marvel that we know as much as we do.

When the Feychting-Ahlbom results were released in 1992, the Swedish government said that it believed that, more likely than not, the cancer link existed.¹⁴ Two years later, the Swedes did not reject this conclusion, but decided that they could not rationalize the high economic costs of regulating EMFs given the rarity of childhood leukemia. Swedish government officials have made it clear that if the hypothesized EMF role in breast cancer were to be confirmed they would reconsider the decision.¹⁵ Feychting and Ahlbom are now working on an epidemiological study of EMFs and breast cancer.

The significance of the epidemiological studies is not that they point to a cancer epidemic. But they raise the question: If EMFs can cause even a small change in cancer rates, what other biological effects could they have?

In the absence of detailed studies on breast cancer, Alzheimer's disease and depression, among other common health problems, no one knows how great the EMF health risk really is. Those who argue that we now have enough research to conclude that the risk is small, if it exists at all—as Dr. Jack Sahl of Southern California Edison does in a recent report¹⁶—are engaging in wishful thinking.

The reason the EMF problem has attracted so much attention is not because of pressure from the scientific community. It is the public that has propelled EMFs into the limelight. The Omaha housewives whose children have cancer want answers, as was shown on *Frontline*. Palfreman portrayed them as naïfs who have been brainwashed by Paul Brodeur. This is unfair because they have legitimate concerns and because they are victims of the scientific uncertainty that is a result, in large measure, of years of industry and government foot-dragging.

* * *

So, the animal, cellular and human studies all point to real risks. And physics does not put them out of the realm of possibility. To be sure, these risks have not been conclusively proven—but neither have they been convincingly dismissed.

As the NCRP committee concluded in its draft report: “[F]indings are sufficiently consistent and form a sufficiently coherent picture to suggest plausible connections between ELF EMF exposures and disruption of normal biological processes, in ways meriting detailed examination of potential implications in human health.”

Yet Palfreman is sure he already has the answers. After a quick breeze through the literature and talking to a few like-minded scientists, Palfreman thinks he knows better than the expert NCRP committee that studied the issue for a decade. “The thesis is mine,” he said in an interview. “It's very clear-cut, I don't feel any doubt.”

Palfreman's show was simply an exercise in hubris. Only this can explain why Palfreman is willing to follow in Buffler's footsteps in waging a holy war against prudent avoidance. Neither sees the point, for instance, in telling parents that they may be protecting their kids simply by moving a bed across a room out of a 10 mG field. As Julie Larm, one of the mothers on the show, wrote to Palfreman on behalf of Omaha Parents for the Prevention of Cancer after the June 13 broadcast, “May God help you if you're wrong.”

Commentary: Missing Pieces of the EMF Puzzle

1. C.V. Byus, Y. Ma and M.A. Stuchly, "The Ability of Magnetic Fields To Serve as a Co-Promotional Stimulus to the Development of Papillomas on the Skin of the Mouse," Paper No.18-3, *17th Annual Meeting of the Bioelectromagnetics Society (BEMS)*, Boston, June 18-22, 1995.
2. T. Kumlin et al., "A Study of the Possible Cancer-Promoting Effects of 50 Hz Magnetic Fields on UV-Initiated Skin Tumors in ODC-Transgenic Mice," Paper No.P-126C, *BEMS*, 1995.
3. W. Löscher et al., "Tumor Promotion in a Breast Cancer Model by Exposure to a Weak Alternating Magnetic Field," *Cancer Letters*, 71, pp.75-81, 1993; W. Löscher et al., "Effects of Weak Alternating Magnetic Fields on Nocturnal Melatonin Production and Mammary Carcinogenesis in Rats," *Oncology*, 51, pp.288-295, 1994; W. Löscher and M. Mevissen, "Animal Studies on the Role of 50/60 Hertz Magnetic Fields in Carcinogenesis," *Life Sciences*, 54, pp.1531-1543, 1994; M. A. Baum et al., "A Histopathological Study on Alterations in DMBA-Induced Mammary Carcinogenesis in Rats with 50 Hz, 100 μ T Magnetic Field Exposure," *Carcinogenesis*, 16, pp.119-125, 1995; M. Mevissen, M. Kietzmann and W. Löscher, "In vivo Exposure of Rats to a Weak Alternating Magnetic Field Increases Ornithine Decarboxylase Activity in the Mammary Gland by a Similar Extent as the Carcinogen DMBA," *Cancer Letters*, 90, pp. 207-214, 1995. See also *MWN*, J/A93, S/O94, J/F95 and M/A95.
4. J.D. Saffer, S.J. Thurston and N.H. Colburn, "Carcinogenesis in Weak Electromagnetic Fields," Paper No.A-14, *Annual Review of Research on Biological Effects of Electric and Magnetic Fields from the Generation, Delivery and Use of Electricity (DOE)*, Albuquerque, NM, November 6-10, 1994.
5. J.D. Saffer, S.J. Thurston and N.H. Colburn, "Tumor Promotion in JB6

- Cells by Weak Electromagnetic Fields," Paper No.1-5, *BEMS*, 1995.
6. R.W. West et al., "Enhancement of Anchorage-Independent Growth in JB6 Cells Exposed to 60 Hz Magnetic Fields," *Bioelectrochemistry and Bioenergetics*, 34, pp.39-43, 1994. See also *MWN*, J/F95.
7. Maria Feychting and Anders Ahlbom, "Childhood Leukemia and Residential Exposure to Weak Extremely Low Frequency Magnetic Fields," *Environmental Health Perspectives, Supplement 2*, pp.59-62, 1995.
8. See *MWN*, M/J95.
9. Emphasis added. See *MWN*, S/O93.
10. D. Hafemeister, *Background Paper on Power Line Fields and Public Health*, Washington: American Physical Society, May 1995.
11. A. Sastre et al., "Residential Magnetic Field Transients: How Do Their Induced Transmembrane Voltages Compare to Thermal Noise?" Paper No.A-33, *DOE*, 1994; and G.B. Johnson, R. Kavet and A. Sastre, "Residential Magnetic Field Transients: Effect of Residential Services on Fields Arising from Distribution Line Capacitor Bank Switching," Paper No.P-130A, *BEMS*, 1995.
12. See *MWN*, N/D94.
13. P. Brodeur, "Annals of Radiation: Calamity on Meadow Street," *The New Yorker*, pp.38-72, July 9, 1990; reprinted in P. Brodeur, *The Great Power Line Cover-Up*, Boston: Little Brown and Co., 1993.
14. See *MWN*, S/O92.
15. See *MWN*, M/J94.
16. J.D. Sahl and B.S. Murdock, *Electric and Magnetic Fields and Human Health: A Review of the Issues and the Science*, Azusa, CA: Southern California Edison, April 1995.

FROM THE FIELD

Clippings from All Over

In 1988, shortly before he died, Andrei Sakharov commented on the fate of the earth. Interestingly enough, rather than comment on the hydrogen bombs that he coined, he stated: "...in fact, I am now inclined to regard the many-faceted ecological threat to our environment as our most serious long-term problem." Because I agree with this very long-term assessment, it is troubling to me to see environmental funds and political capital wasted on false threats. In particular, I am concerned that the quasi-legalistic concept of "prudent avoidance" is being used to chase the phantom risk of cancer caused by extremely low frequency (ELF) [EMFs] from power lines. This needless chase costs some \$1 billion to \$3 billion per year and unnecessarily frightens the public with "electrophobia." The burden of these fiscal and emotional costs placed on the American public are incommensurate with the risk, if any, being mitigated. This outcome is not a use of science for the public good.

—David Hafemeister, "The Imprudence of 'Prudent Avoidance'," *Physics & Society*, a publication of the American Physical Society, p.9, July 1995

[B]ut it is only a matter of time before a jury returns a favorable verdict to plaintiffs in an EMR case.

—Bruce DeBoskey, "Electromagnetic Radiation and Cancer: Recent Developments," *Trial*, a publication of the Association of Trial Lawyers of America (ATLA), p.21, July 1995

In March of 1994, alliance member Julie Larm met with President Bill Clinton and asked him to execute an executive order creating a buffer zone between homes, schools, day care centers and nursing homes and any electrical generating facility, such as transmission and distribution lines and electrical substations. The alliance has continued a year-long letter campaign urging Clinton to sign this executive order with hope that the White House would focus on this issue. However, over a year has passed since the White House promised to

look into the health hazards surrounding exposure to EMF. The cover story of our spring 1995 issue of *Network News* was entitled "The White House White Wash: Clinton Ignores the EMF Issue" and prompted a letter from President Clinton to me a few weeks ago assuring me that the EPA was continuing to review the EMF issue. Although I am not from Missouri—I'll stand by Missouri's "Show Me" state motto. Show me, then I'll believe it. The Clinton Administration has continually taken the "ostrich" position on EMF, as did the Bush Administration before it. It has fallen to the shoulders of the citizen activist to resolve this issue at a grassroots level.

—Cathy Bergman-Venezia, "Introducing the EMR Alliance: Grassroots Group Looks for a Safe Environment," *1995 ATLA Annual Convention*, New York City, p.8, July 17, 1995

"We [epidemiologists] are fast becoming a nuisance to society," says Dr. Dimitrios Trichopoulos. "People don't take us seriously anymore, and when they do take us seriously, we may unintentionally do more harm than good." As a solution, epidemiologists interviewed by *Science* could suggest only that the press become more skeptical of epidemiologic findings, that epidemiologists become more skeptical about their own findings—or both.

—Gary Taubes, "Epidemiology Faces Its Limits," *Science*, p.164, July 14, 1995

"The worst aspect of mobile phones is that they probably interrupt my meal in restaurants."

—Dr. Michael Repacholi, chairman, International Commission on Non-Ionizing Radiation Protection, appearing on ABC-TV's (Australia) *Four Corners* in "Waves of Fear," aired July 10, 1995

"Don't put the antenna right against your head. Now that is the sort of information that should be imparted to the user [of cell phones]."

—Dr. Ross Adey, associate chief of staff for R&D, VA Hospital, Loma Linda, CA, also on *Four Corners*, July 10, 1995

The draft emphasizes that “mitigation of existing exposures...is likely to prove complex and costly.” But with regard to new construction, committee members argue for “exercising these options now at a time when their implementation will carry minimal societal impact or fiscal burden.” They underline the importance of “planning for the future of a society wherein use of electric power will continue to grow at every turn.”

The committee concludes that “neither laboratory studies nor epidemiological findings...can yet establish well-defined thresholds for safety guidelines.” Still, it contends:

From available epidemiological and laboratory data, it appears both prudent and responsible to set limits on permissible future exposures.

Therefore it calls for “interim exposure guides,” measures that “fall short of establishing either a standard or guideline, but offer guidance to limit exposure.”

ALARA Policy Endorsed

While the report notes that committee members were not unanimous, it recommends a policy in which exposures would be “as low as reasonably achievable,” known as ALARA. Over a three-year period, ambient exposures in homes, schools and offices would be reduced to 10 mG. After six years, there would be an option to establish a guideline of 5 mG. Each of these decisions would be based on whatever epidemiological and laboratory studies were then available. After ten years, a goal of 2 mG would be considered. The report stipulates that mitigation of the existing EMF environment to this level should be adopted only after “a careful evaluation of its socioeconomic impact, as well as its cost-effectiveness.”

“We worked very hard to come up with a statement where we could say, these are the committee’s recommendations, even though we don’t agree on everything,” said Dr. Mary Ellen O’Connor of the University of Tulsa, OK, a member of the committee. As another committee member, who asked not to be identified, said, “Some members felt it was important to set numerical limits, while others felt it was inappropriate at this time.”

The committee rejected the option of not issuing any specific recommendations on exposures. It also rejected another option—to set a 2 mG exposure guideline immediately—on the grounds that “general compliance would appear impractical at this time.” As Adey pointed out, “We must be realistic that we are not going to give up electric power. Its use will continue to grow in a civilized society.”

Committee member Dr. David Carpenter, of the School of Public Health at the State University of New York, Albany, said, “In almost any other type of environmental exposures, if the evidence were as strong as the association between EMFs and cancer, there would be extensive government regulation. The major reason that many members of the committee were unwilling to set more rigorous standards was that it would be horrendously expensive and unrealistic to enforce them.”

With respect to future construction, the report recommends observing a 2 mG exposure limit for schools and for new trans-

Committee Members

The members of NCRP Scientific Committee 89-3 on Extremely Low Frequency Electric and Magnetic Fields are: Dr. Ross Adey (chair), VA Hospital, Loma Linda, CA; Dr. Larry Anderson, Battelle Pacific Northwest Labs (PNL), Richland, WA; Dr. Carl Blackman, EPA, Research Triangle Park, NC; Dr. David Carpenter, State University of New York, Albany; William Feero, Electric Research and Management Inc., State College, PA; Dr. Marvin Frazier, Department of Energy, Washington; Dr. Richard Lovely, Battelle PNL, Seattle; Dr. Richard Luben, University of California, Riverside; Dr. Martin Misakian, National Institute of Standards and Technology, Gaithersburg, MD; Dr. Mary Ellen O’Connor, University of Tulsa, OK; and Dr. Richard Stevens, Battelle PNL, Richland.

mission lines near existing housing, with somewhat less strict guidelines for new housing and offices.

The report notes that its proposed benchmarks can serve as “a vehicle for public instruction.” While large-scale education of individuals “may be difficult to achieve,” the document stresses the importance of changing institutional practices “on such topics as grounding in electrical distribution systems [and] manufacturing of appliances.”

Adey described the committee’s members as “carefully selected to cover the great majority of societal interests on this scientific problem, including power industry engineers, epidemiologists, public health specialists as well as molecular and cellular biologists” (see box above for a list of members). Dr. Richard Stevens of the Battelle PNL in Richland, WA, commented that, “There were some differences of opinion on the weight of the evidence, but my impression is that there was agreement on the importance of the issue and that it deserves continued attention.”

EPA Cancer Report Due Soon

The draft report is the culmination of work that began in 1983, when the EPA contracted with the congressionally chartered NCRP for a review of the biological effects of extremely low frequency (ELF) EMFs (see *MWN*, D83). Work was discontinued in 1986 because of funding cuts at the EPA, but resumed in 1991, according to EPA’s Elder. “It took a million years,” said O’Connor.

Adey noted that, “The committee’s position evolved each year with the growing body of credible laboratory and epidemiological studies.” In its review of the research, the report examines evidence for EMF effects on cancer growth, reproduction and embryo development, and neurobiology.

The NCRP committee’s conclusions bolster the findings of a 1990 draft on EMFs developed by the EPA (see *MWN*, M/J90). That EPA report is now being revised, but the agency does not appear to be backing away from its most important conclusions (see *MWN*, S/O94). McGaughy, of EPA’s Office of Health and Environmental Assessment in Washington, said that it would probably be completed by October or November and would be reviewed by EPA’s Science Advisory Board after a 60-day public comment period.

SPECIAL REPORT

NCRP Draft Recommendations on EMF Exposure Guidelines

Reprinted below is Section 8 of the June 13, 1995, draft of the report of NCRP Scientific Committee 89-3 on Extremely Low Frequency Electric and Magnetic Fields, which contains its conclusions and recommendations.

8.1.0 Conclusions and Recommendations for Interim Exposure Guidelines

In 1989, the International Radiation Protection Association (IRPA) approved interim EMF exposure guidelines prepared by its International Non-Ionizing Radiation Committee. The guidelines recommended the following limits for occupational exposure and for exposure of the general public:

Exposure	Table 1	
	Electric Field Strength	Magnetic Flux Density
<i>Occupational:</i>		
Whole Working Day	10 kV/m	0.5 mT (= 5,000 mG)
Short Term	30 kV/m	5.0 mT (= 50,000 mG)
Restricted to Limbs	—	25.0 mT (= 250,000 mG)
<i>General Public:</i>		
Up to 24 hours/day	5 kV/m	0.1 mT (= 1,000 mG)
Few hours/day	10 kV/m	1.0 mT (= 10,000 mG)

The IRPA committee based its recommendations on the premise that the existing literature does not provide evidence that EMF exposures at present-day levels have a public health impact that would require corrective action. Its summary position was that "although some epidemiological studies suggest an association between exposure to 50/60 Hz fields and cancer, others do not. Not only is this association not proven, but present data do not provide any basis for health assessment useful for the development of exposure limits."

Further, the IRPA guidelines were developed "primarily on established or predicted health effects produced by currents induced in the body by external [EMFs]," and those limits correspond to induced current densities that are generally at, or slightly above, those attributable to normal excitation currents occurring physiologically in the body. Thus, the IRPA-recommended exposure limits are orders of magnitude greater than field levels that may create a risk, in the light of extensive evidence reviewed in this report. Concerns about inadequacies of IRPA guidelines have been summarized in a review of international standards (Gibbs, 1991)¹:

Since the guidelines proceed on the basis that adverse human health effects from exposure to ELF electric fields at strengths normally encountered in the environment or in the workplace have not been established, it is apparent that they are not intended to provide protection against any adverse health effects that may be caused by such exposure, and they would not do so. The levels of exposure recommended are many times greater than the levels at which it has been suggested that the fields may create a risk.

In the U.K., the National Radiological Protection Board (1989) also set exposure guidelines for 50/60 Hz fields on the same basis as the IRPA committee in fixing its interim guidelines. For occupational exposures and for the general public, the recommended 50 Hz field levels were the same: for electric fields: 12 kV/m; for magnetic fields: 2 mT (20,000 mG).

In the USA, some states have established limits for electric field strengths on or at the edge of the rights-of-way for high voltage transmission lines. Only Montana has established magnetic field limits (Table 2).

Exposure criteria at these levels do not reflect epidemiological findings that suggest significantly enhanced cancer risks, particularly

¹ H. Gibbs, *Inquiry into Community Needs and High-Voltage Transmission Line Development*, Report to Minister for Minerals and Energy, New South Wales State Government, Australia. 163 pp., 1991.

for childhood leukemia, in ambient power frequency fields exceeding 2 mG. This level is proposed for a Swedish general population guideline, based on correlates of incidence of childhood leukemia with annualized magnetic field levels in dwellings adjacent to high voltage transmission lines.

8.2.0 Rationale for Interim Exposure Guides

In reviewing available evidence, neither laboratory studies nor epidemiological findings, whether considered separately or jointly, can yet establish well-defined thresholds for safety guidelines that would encompass the temporal spectrum from short-term to lifelong ELF exposures. Although it might thus be justified to offer no specific guidelines, nevertheless it would appear prudent to offer interim guidance.

Population exposure to EMFs at power line frequencies involves not only the basic sine wave fields at 50 or 60 Hz, but also harmonics at higher frequencies. Secondary fields generated in the use of electric power are substantially more complex due to their harmonic content. Although this report focuses on the ELF spectrum from near-DC to 300 Hz, information has been included on studies as high as the kilohertz range, because of their widespread environmental occurrence and because they have not been reviewed elsewhere.

In key areas of bioelectromagnetic research, findings are sufficiently consistent and form a sufficiently coherent picture to suggest plausible connections between ELF EMF exposures and disruption of normal biological processes, in ways meriting detailed examination of potential implications in human health. These specific areas of research are briefly reviewed.

8.2.1 Carcinogenesis

Epidemiological studies in the USA and Europe cited elsewhere indicate a positive association between childhood cancers and exposure to magnetic fields, on the order of 0.2 μ T, generated by electric power transmission and distribution systems. Evidence has accumulated in other epidemiological studies implicating exposure to ELF EMFs as a factor common to an increased incidence of leukemia and brain cancer in occupationally exposed adults.

In laboratory research, further studies will be necessary to determine existence of an unequivocal link between exposure to ELF EMFs and cancer. Nevertheless, reported EMF effects in animal and tissue models at critical steps in cell growth regulation are consistent with an initiation-promotion (epigenetic) model of tumor formation, and are consistent with results of epidemiological studies.

State	Table 2*	
	On ROW**	Edge of ROW
Florida [§]	8 kV/m	2 kV/m
Florida [†]	10 kV/m	2 kV/m
Minnesota	8 kV/m	—
Montana	7 kV/m	1 kV/m
Montana [§]	—	150 mG
Montana [†]	—	200 mG
Montana [‡]	—	250 mG
New Jersey	—	3 kV/m
New York	11.8 kV/m	1.6 kV/m
North Dakota	9 kV/m	—
Oregon	9 kV/m	—

* After Gibbs¹ ** ROW = Right-of-Way
[§]lines \leq 230 kV [†]500 kV lines [‡]500 kV double circuit lines

8.2.1.1 Gene induction: There is no evidence of gross chromosomal damage or sister-chromatid exchanges following exposure to ELF EMFs, interpreted as an indication that field exposure does not cause initiation as the first step in the initiation-promotion cancer model. However, ELF magnetic fields have been shown to alter gene transcriptional processes, with repression and derepression of portions of the genetic code, thus leading to changes in expression of proteins in cells. This process may represent an abnormal cell function, leading to reduced control of cell growth, and ultimately to unregulated growth. Such a loss of growth regulation would be consistent with a promotional role (or copromotional with other promoting agents) in the cancer process.

8.2.1.2 Biochemical changes: Intracellular biochemical changes following ELF magnetic field exposures. They include responses of messenger and cell growth-related enzymes, and alterations in gene expression, including modulation of activity of proto-oncogenes. These changes are consistent with actions of chemical cancer promoters, suggesting the possibility of combined actions of chemicals and ELF EMFs as cancer promoters.

8.2.1.3 Enhanced cell tumorigenicity: Increased tumor incidence and decreased tumor latencies have been reported in animal tumor models when 50/60 Hz magnetic fields at intensities of 0.1 mT or less were presented as promoters or copromoters. Increased concentrations of transferrin receptors have been reported on the surface of human colon cancer cells when exposed to 60 Hz magnetic fields, or to combined electric and magnetic ELF fields. A relationship to increased tumorigenicity may be suggested, since raised serum iron levels and an associated decrease in levels of transferrin iron binding have been described in human cancer. These findings are consistent with the possibility that prolonged exposures to ELF fields may progressively lead to recloning of already transformed cells to a more cancerous state.

8.2.1.4 Immune deficiencies: Accumulating epidemiological evidence from population studies and from the workplace now correlates environmental ELF EMF exposures with increased risks for leukemia in children and adults. Certain of these studies have suggested a dose-dependence in long-term exposures. In laboratory studies, the natural defense response of T-lymphocytes taken from the immune system of mice is reduced by exposure to ELF electric fields, and after exposure to combinations of electric and magnetic fields. It may be argued that if these exposures mitigate normal immune defense responses in the intact subject, there may ensue less efficient detection and elimination of aberrant cells, including cells undergoing recloning to more malignant states.

8.2.2 Reproduction/Teratology

Unlike the growing and increasingly consistent evidence linking ELF EMF exposure to increased risks of certain cancers, epidemiological evidence on human reproduction has remained limited. A single preliminary study has described a modest increased risk of pregnancy termination associated with use of electric blankets.

A series of studies in Scandinavia and the USA have reported increased risks of miscarriage associated with VDT use, including evidence of dose-dependency. Studies in mice, rats and swine have all reported teratological effects, but many lack consistency in site and type of teratology. Several independent studies have noted growth abnormalities in chick embryos exposed to similar types of magnetic fields. A single study in rats of neuroendocrine and psychosexual responses following intrauterine ELF magnetic field exposure in late pregnancy has described defective territorial marking in adult male offspring and increased gonadal organ weights.

Available evidence from these epidemiological and laboratory studies indicates needs for further research on possible reproductive anomalies, including studies of subtle neurobehavioral effects that may be revealed only after puberty and in later development.

8.2.3 Neurobiology

Limited human studies have addressed a spectrum of altered physiological responses that appear correlated with ELF electric and magnetic field exposures. This spectrum of bioeffects shades progressively into certain neuroendocrine and autonomic responses which, separately or collectively, may have pathophysiological implications. These human observations are supported and extended by a much larger body of laboratory animal research, with responses to ELF fields in species from fish to man. These fields may influence development of the nervous system. In the adult organism, they elicit neurochemical, physiological, behavioral and chronobiological responses.

There has been a strong focus on ELF field actions in the pineal gland, relating to effects on synthesis and secretion of the pineal hormone *melatonin*, and on a broad series of regulatory functions mediated by this hormone. Melatonin plays a key role in controlling the 24-hour daily biological rhythm. Disturbance of the normal diurnal melatonin rhythm is associated with altered estrogen receptor formation in the breast, a line of experimental evidence now under study for possible links between ELF field exposure and human breast cancer. Further, melatonin has general properties as a free radical scavenger, with the possibility of a preventative role in oxidative stress, recognized as a basic factor in a broad spectrum of human degenerative disorders, including coronary artery disease, Parkinson's and Alzheimer's diseases, and aging.

8.3.0 Conclusion

Although incomplete, available epidemiological and laboratory data share certain consistencies that would link ELF environmental EMFs with increased health risks. These findings appear to warrant a substantive national commitment to further research, and the serious attention of cognate regulatory agencies and of the general public. Some epidemiological studies relate health effects to broad measures of exposure levels. From these measures, there is an implication that a significant proportion of the world's population may be subjected to a low level of risk, but a risk factor with significant societal consequences, by reason of its pervasive nature and the serious consequences for affected individuals. Much additional research will be necessary to determine the complex nature of dose-response relationships, and the specific contributions of field frequency, intensity and waveforms. A deeper knowledge of mechanisms is needed to elucidate observed differences between intermittent and chronic ELF field exposures. In establishing safety guidelines, there may also be a need to identify populations with specific sensitivities, as is customary with certain chemical toxins. As yet, no research has examined possible synergisms between EMFs and other environmental agents. Further, many electrically operated appliances, such as television receivers, computer display terminals and certain types of electric motors, may generate substantial magnetic fields in their immediate vicinity at frequencies above the ELF spectrum. Although beyond the scope of this report, these fields may also be biologically active. A broader base of experimental data will be required before there can be regulatory implementation of comprehensive safety guidelines; but this considered approach in no way diminishes the desirability of interim standards.

8.4.0 Interim Exposure Guides

Based on available evidence, the committee concludes that it is desirable to reduce human exposure to electric and particularly to magnetic fields over the frequency range from near-zero to 3 kHz. This may be accomplished, particularly in areas with frequent and prolonged human occupancy, by recommending an exposure standard, or a set of safety guidelines; or by recommendations that fall short of establishing either a standard or guideline, but offer guidance to limit exposure.

The past century has seen exponential growth in the universal

use of electric power in every facet of civilized society. With this universal acceptance, engineering considerations have driven the developing technologies of power generation and distribution in ways offering few options for possible changes dictated in the hindsight of either environmental or medical concerns. The burden of fiscal investment alone may make unfeasible drastic modifications of existing systems in the short term.

The committee has therefore addressed these questions of safety in an historical perspective. What safety issues may arise from continuing exposure to existing environmental fields? And for the future, should these exposures be mitigated, and if so, to what levels? Beyond an evaluation of existing exposures, a more pressing issue involves planning for the future of a society wherein use of electric power will continue to grow at every turn.

On the one hand, mitigation of existing exposures may be appropriate in certain instances where exposures may be deemed excessive, based on available epidemiological and laboratory data. In planning for the future, societal impact of this mitigation is likely to prove complex and costly. Prior to implementing major mitigation programs, they will require rigorous evaluation of their risk/benefit ratios. An approach developed by cognizant federal agencies in handling some environmental toxic agents has involved incremental safety guidelines that reflect growth of medical knowledge and availability of improved or more cost-effective mitigation techniques over a period of years.

By contrast with deep-rooted problems inherent in mitigation of many existing exposures, plans for the future should address exposure guidelines in new construction of housing, schooling and industrial plants, with specification of acceptable interior electromagnetic environments, as well as proximity to existing electric power transmission and distribution systems. A second concern addresses construction of new power transmission and distribution systems, and their permissible proximity to existing houses, schools and industrial developments

Although precise numerical levels in safety guidelines covering current environmental exposures may require further research, there is a different perspective on needed guidelines for the future of an increasingly electrified society. From available epidemiological and laboratory data, it appears both prudent and responsible to set limits on permissible future exposures, exercising these options now at a time when their implementation will carry minimal societal impact or fiscal burden.

8.4.1 The Existing ELF Electromagnetic Environment

With respect to the existing electromagnetic environment, four options were considered:

8.4.1.1 Option 1: No recommendation for use of specific field levels to define an exposure safety guideline: *EMFs from distribution and use of electric power have created new exposures in the human environment. Virtually no one in Western society escapes some form of exposure. For that reason, there should be a continuing aggressive pursuit of possible adverse health effects from these exposures. However, the existing evidence bearing on health effects is inadequate to offer exposure guidelines at this time. There is not sufficient consistency among epidemiological studies, and with very few animal studies reported, it is premature to assume a causal relationship between EMF exposure and cancer risk.*

Though not sufficient to conclude causality, the epidemiological studies have raised concern. In addition, animal models for skin and breast cancer are in the early stages of evaluation and preliminary results have been provocative. Despite their logical complexity, further rigorous testing of animal models may offer one of the few options for full elucidation of a possible role of EMFs in tumor formation, since it is unlikely that these data will be derived from epi-

demiological studies alone.

It must be emphasized that epidemiological studies completed to date do not rule out effects of EMFs on cancer risk, even large ones. This is because of limitations in exposure assessment and undoubted misclassification of exposure, as well as the absence of truly unexposed subjects.

8.4.1.2 Option 2: An exposure guideline of 0.2 μ T and 10 V/m: *Epidemiological evidence points to human health hazards in exposure to ambient power frequency magnetic field environments exceeding 0.2 μ T. A dose-dependence for childhood leukemia is suggested for power frequency fields in the range 0.2-0.4 μ T. Assessment of the ambient magnetic environment in these studies at sites near power transmission and distribution lines has generally not taken account of much higher but more focal fields in the immediate vicinity of operating devices in the home and workplace. Resulting risk estimates may thus underestimate the true exposure levels from all sources. Although largely neglected in the emphasis on magnetic field bioeffects, there is also a body of laboratory evidence relating biologically significant effects, particularly in cerebral tissue calcium binding, to ELF electric field exposures in the range 10-100 V/m. Neurobehavioral effects, including a regulatory role in biological rhythms of man and animals, have been attributed to ELF environmental electric fields at intensities in the range 10-100 V/m.*

Safety guidelines established at the low levels of Option 2 could be expected to have a major impact on lifestyles and working conditions in homes and in most occupational settings. Mitigation of existing fields needed to achieve general compliance would appear impractical at this time.

8.4.1.3 Option 3: An exposure guideline of 1 μ T and 100 V/m: *A considerable body of observations has documented bioeffects of fields at these strengths across the gamut from isolated cells to animals, and in man. Although the majority of these reported effects do not fall directly in the category of hazards, many may be regarded as potentially hazardous. Since epidemiological studies point to increased cancer risks at even lower levels, a case can be made for recommending 1 μ T and 100 V/m as levels not to be exceeded in prolonged human exposures. Most homes and occupational environments are within these values, but it would be prudent to assume that higher levels may constitute a health risk.*

In the short term, a safety guideline set at this level would have significant consequences, particularly in occupational settings and close to high voltage transmission and distribution systems, but it is unlikely to disrupt the present pattern of electricity usage. These levels may be exceeded in homes close to transmission lines, distribution lines and transformer substations, in some occupational environments, and for users of devices that operate close to the body, such as hair dryers and electric blankets. From a different perspective, adoption of such a guideline would serve a dual purpose: first, as a vehicle for public instruction on potential health hazards of existing systems that generate fields above these levels, as a basis for "prudent avoidance"; and second, as a point of departure in planning for acceptable field levels in future developments in housing, schooling, and the workplace, and in transportation systems, both public and private, that will be increasingly dependent on electric propulsion.

8.4.1.4 Option 4: The ALARA concept (as low as reasonably achievable): *The ALARA concept derives from guidelines for exposure to ionizing radiation. In that context, it first requires acceptance of a specific numerical guideline, and thereafter, due diligence in seeking progressive exposure reduction to levels at or below the guideline. Although the aggregate evidence suggests a significant health risk from these fields, there is as yet inadequate information to establish thresholds that would implicate specific field levels as safe or hazardous. Therefore, in the interval required for further research, individuals, industries and govern-*

ment agencies would have responsibilities to make human exposures as low as reasonably achievable in meeting a postulated numerical exposure guideline developed as part of an ALARA scheme.

An ALARA approach also offers an avenue to safety guidelines to be implemented incrementally. An incremental approach to dealing with potential environmental hazards is a model successfully employed by the Environmental Protection Agency, in joint actions with other federal agencies, in dealing with toxic waste cleanup. Appropriate benchmarks are established that project realizable goals at stated future times. An incremental approach on a large scale has been applied by EPA to the control of automobile emissions in Southern California, under the federal Clean Air Act.

Based on Option 3, a set of ALARA goals may be defined with benchmarks projected over a minimum of six and a maximum of ten years, as a template for an incremental guideline. In homes, schools, nonindustrial workplaces, and in suburban environments, a first ALARA benchmark at three years should reduce ambient exposures to 1.0 μT [and] 100 V/m (Option 3). Thereafter, a second benchmark at six years would set a goal at 0.5 μT [and] 50 V/m. Beyond this point, implementation of the third benchmark in an incremental safety guideline for the general public at a further sharply reduced level (as in Option 2) at 0.2 μT [and] 10 V/m will require a careful evaluation of its socioeconomic impact, as well as its cost-effectiveness. It would not be expected to occur until about seven years after implementation of benchmark 1. Its justification would also be based on new correlated laboratory and epidemiological data expected to be available over the next decade.

For individuals, educational requirements inherent in this ALARA scheme may be difficult to achieve; but at the societal level, there should be a technological focus on such topics as grounding in electrical distribution systems, manufacturing of appliances designed to reduce stray field levels, and elevation of consumer awareness of possible hazards associated with particular appliances.

8.4.2 Conclusion on an Interim Exposure Guideline for the Existing Electromagnetic Environment

Though not unanimous, the predominant view of the committee is to recommend the ALARA approach. It is proposed that this ALARA guideline be progressively implemented over a ten-year period. It is recommended that specific field levels cited here be regularly reviewed as more information becomes available that might suggest either more or less stringent figures as the basis for a continuing ALARA policy. Specifically, the pathophysiology of cumulative dose has yet to be defined, and with it, the relevant parameters in long-term EMF exposure.

The proposed initial benchmark for a safety guideline would be developed under Option 3. After three years, maximum acceptable field levels would not exceed 1.0 μT and 100 V/m over the spectrum from near-zero to 3.0 kHz in homes, schools, and other non-industrial environments. In a review after six years, there would be an option to establish a guideline at 0.5 μT and 50 V/m. Thereafter, at ten years, and only after full review of socioeconomic as well as its technical implications, there would be an option to establish a guideline at 0.2 μT [and] 10 V/m. There would be options to truncate both lead times and acceptable field parameters if favored by availability of appropriate laboratory or epidemiological evidence.

With respect to occupational exposures, the committee reviewed the composite nature of exposures in the workplace, where EMFs, often at high levels, coexist with a variety of chemical factors known to be hazardous, including neurotoxins, pesticides, herbicides and organic solvents. Although there is evidence that EMFs may promote actions of these chemical factors in pathogenesis of human disease, particularly in relation to joint exposures over many years, these data are insufficient for evaluation of their joint or separate roles. More-

over, in most instances, economic considerations would render unfeasible a major reduction in existing industrial field levels through engineering approaches. These exposures may also involve high levels of static magnetic fields, for which there is very little relevant laboratory or epidemiological data.

In typical office environments, ambient field levels may differ very little from domestic ambients. The committee therefore recommends use of the incremental ALARA guideline described above. However, the industrial workplace may involve intermittent or continuous exposure to fields orders of magnitude higher. In these situations, the committee also recommends an ALARA approach for 60 Hz fields, but with an awareness that neither major reductions in existing field levels, nor options to significantly reduce operating personnel exposures are immediately feasible on technical or economic grounds. As a long-term (ten-year) goal, an ALARA approach to mitigation in existing industrial environments would envisage a time-limited personnel exposure not exceeding one hour in any eight-hour workshift, and with time-averaged fields not to exceed 10 μT and/or 1 kV/m for any one hour in an eight-hour workshift. This guideline does not address magnetic transients associated with starting or stopping large inductive devices. Its development towards time-limited exposures is suggested by laboratory reports of ELF and RF exposures that modulate immune cell functions in a time-dependent manner.

The committee recommends further research into field mitigation, including the possibility of developing protective clothing capable of magnetic shielding, as a possible option in personnel protection in high-level industrial magnetic fields.

8.5.0 Exposure Guidelines Relating to Future Developments Affecting the ELF Electromagnetic Environment

There may be important societal options in considered planning for the future of electric power transmission, distribution and use. Planned development may avoid hazards and pitfalls of existing systems, and by offering guidance in new construction, may avoid much of the heavy economic impact inevitable in retrofitting and mitigating suspected health hazards associated with past and present technologies.

As safety guidelines for future planning, the committee recommends that: 1) *New day care centers, schools and playgrounds should not be built where ambient 60 Hz magnetic fields exceed 0.2 μT* ; 2) *New housing should not be built under existing high voltage transmission lines, or in such close proximity to these lines that measured ambient field levels would exceed 0.2 μT for periods longer than two hours daily*; 3) *New transmission and distribution lines should not be built in locations where they would produce fields exceeding 0.2 μT in existing housing*; 4) *In new office and industrial environments, design considerations should encompass problems of personnel exposure to high magnetic field levels, with the aim of reducing intermittent and ambient exposures to a 0.2 μT level, over the spectrum from near-zero to 3.0 kHz.*

8.5.1 Conclusion

In arriving at the proposed guidelines, the committee has considered available laboratory studies on bioeffects and epidemiological reports of health hazards from electric and magnetic field exposure. Lacking a basis for calculation of cumulative dose, these guidelines have been determined without drawing distinctions between acute and chronic exposure. They have not determined exposure levels from safety factors frequently used with other agents, nor has there been special consideration for sex, age or potentially sensitive populations, such as pregnant women, because current knowledge of mechanisms of field interactions does not allow identification of those likely to be affected. In medical diagnostic and therapeutic applications, these guidelines would exclude patients, but would apply to physicians, nurses and to all other health providers.

BOOKS

Technical Primer on EMFs...A new book from CRC Press, *Power Frequency Magnetic Fields and Public Health*, explains how to estimate the strength and distribution of magnetic fields produced by the use of electric power. Coauthors William Horton and Saul Goldberg, both professors of electrical engineering at California Polytechnic State University in San Luis Obispo, write that they wanted the book to be accessible to “a nontechnical reader,” but equally of interest to an engineer, scientist or architect. “The book focuses on characterizing the various kinds of field sources—transmission lines, transformers, ground currents, appliances, and so on—and allows readers to determine what their exposure might be,” Horton told *Microwave News*. A number of two- and three-dimensional contour maps provide clear descriptions of different kinds of fields, from those in a typical residential living room to those around a pad-mounted transformer. The book leads the reader through the equations needed to calculate field strengths, with the most complicated technical material reserved for the appendixes. There is an extensive glossary of technical terms, and a section on how to apply prudent avoidance in one’s daily life. Also on the Cal Poly faculty is Dr. David Hafemeister, author of the background paper for the American Physical Society’s recent statement on EMFs (see *MWN*, M/J95). Hafemeister has recently spoken out against the concept of prudent avoidance (see p.10). Horton said that he and Hafemeister are friends and he downplayed any differences in their views: “His conclusion was that it would not be a good use of public funds to make big expenditures to reduce EMFs, and I would have to agree with that. I would just do the simple things, where you can reduce exposure without spending a lot of money.” He added that, “I personally don’t think there’s much danger due to power frequency fields, but if I had a child I wouldn’t put the crib next to the incoming power service. Who knows what the next study’s going to show?” *Power Frequency Magnetic Fields and Public Health* costs \$59.95. Order from: CRC Press, 2000 Corporate Blvd., NW, Boca Raton, FL 33431, (800) 272-7737 or (407) 994-0555, Fax: (800) 374-3401 or (407) 998-9114.

CALL FOR PAPERS

RF/MW Medical Applications...The October 1996 issue of *IEEE Transactions on Microwave Theory and Techniques* will deal with medical applications and biological effects of RF/MW radiation. Those interested in contributing papers on medical therapies, diagnostic techniques or safety issues should contact: Arye Rosen, David Sarnoff Research Center, 201 Washington Rd., CN 5300, Princeton, NJ 08543, or Andre Vander Vorst, Hyperfrequencies, UCL, Bâtiment Maxwell, B-1348 Louvain-la-Neuve, Belgium. Manuscripts are due by this October.

CELLULAR PHONE INTERFERENCE

Astronomers’ Concerns...New forms of mobile telecommunications technology could close the heavens to radio astronomers, according to the European Science Foundation (ESF) in Strasbourg, France. Concerned by plans for mobile phone sys-

**MICRO
WAVE
NEWS**

Now Available!

A Report on Non-Ionizing Radiation

Three reprints from the pages of *Microwave News*:

- **Cellular Phones/Towers**
- **EMFs & Breast Cancer**
- **Police Radar**

\$25.00 Each (Outside the U.S., \$30.00)
Circle Your Selection(s).

Name _____

Organization _____

Address _____

City/State/Zip _____

Enclosed is my check for \$ _____

Prepaid Orders Only.

U.S. Funds or International Money Order, Please.

**MICROWAVE NEWS • PO Box 1799 • Grand Central Station
New York, NY 10163 • (212) 517-2800 • Fax: (212) 734-0316**

tems using satellites in low earth orbit (for instance, Motorola's Iridium system), the ESF warned that, "To succeed, this potentially billion-dollar industry will need access to several frequency bands which are also crucial to the world's radio astronomers." The ESF said that cell phone interference with astronomy is already "a growing problem which the International Telecommunications Union (ITU) appears reluctant to recognize." Dr. James Cohen of the U.K.'s Jodrell Bank radio telescope explained the effects of interference: "It's like [being] a professional photographer who, despite being equipped with the latest in modern cameras, finds that just as he presses the shutter someone else shines a flashlight into his lens." Dr. Peter Napier of the U.S. National Radio Astronomy Observatory in Socorro, NM, said that the ESF's concerns are shared by U.S. astronomers. Napier praised some companies, including Motorola and the American Mobile Satellite Corp., for seeking the input of astronomers as they plan for satellite systems. This November, the ITU will decide which frequencies to allocate to satellite-linked phones.

CELLULAR PHONE TOWERS

When Is a Tree Not a Tree?...The telecommunications industry is branching out into aesthetics. With siting problems plaguing cellular phone companies throughout the country, the industry is looking for a way to camouflage its towers. Arcnet Inc. of Holmdel, NJ, may have the answer with its tree look-alike tower. Modeled after a white pine, the antenna can be 10 feet to 200 feet tall. The "limbs" of the pine tree vary from 2 feet to 14 feet and are made of polyvinyl chloride pipe coated with epoxy resin "bark." Not to worry if you want to erect an antenna tower in the tropics or the desert. Arcnet also is marketing royal palm and saguaro cactus look-alike towers.

COMET ASSAY

Lai-Singh Paper Published...The report by Drs. Henry Lai and Narendra Singh, which has attracted so much attention in the cellular phone community, is now in print (see *MWN*, N/D94). "Acute Low-Intensity Microwave Exposure Increases DNA Single-Strand Breaks in Rat Brain Cells" appears in *Bioelectromagnetics* (16, pp.207-210, 1995), which came out in early July. Lai and Singh, both of the University of Washington, Seattle, used the comet assay to measure DNA damage, a technique that Singh helped develop. In a recent review, Drs. Daryl Fairbairn and Kim O'Neill of Brigham Young University in Provo, UT, and Dr. Peggy Olive of the British Columbia Cancer Research Centre in Vancouver, Canada, conclude that, "The versatility of applications of the comet assay indicates its usefulness in addressing a wide range of questions in biology, medicine and toxicology." See "The Comet Assay: A Comprehensive Review," *Mutation Research*, 339, pp.37-59, February 1995.

MEETINGS

Hypersensitivity Conference...The proceedings of the 2nd

**DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
FOOD AND DRUG ADMINISTRATION
CHIEF, RADIATION BIOLOGY BRANCH**

The Center for Devices and Radiological Health, Food and Drug Administration (FDA) is seeking a qualified individual to serve as Chief, Radiation Biology Branch, Division of Life Sciences, Office of Science and Technology. Responsibilities include direction and development of intra- and extramural FDA-related scientific programs in radiation biology; developing regulatory, educational, and other strategies concerning radiation-emitting products; representing FDA with national and international organizations; and establishing the technical basis for regulatory and policy matters.

A degree in Biology, Microbiology, Biochemistry, or Physics is required with demonstrated research experience in relevant scientific areas in radiation biology. Appointment will be at the GS-15 level. Salary range is \$71,664 to \$93,166.

Appointment may also be made through the U.S. PHS Commissioned Corps for qualified candidates. FDA is an Equal Opportunity Employer. FDA is a smoke-free workplace. U.S. citizenship required.

For information please contact: Dr. Mary E. Jacobs, Director, Division of Life Sciences, HFZ-110, 5600 Fishers Lane, Rockville, MD 20852. Telephone: (301) 443-7115, Fax: (301) 594-6775, E-mail: MEJ@FDADR.CDRH.FDA.GOV

Research Opportunities

The California Public Health Foundation, fiscal manager for the California EMF Program, will soon issue Requests for Proposals (RFPs) for the following projects:

- Prospective Epidemiological Study of Spontaneous Abortion (\$1,200,000);
- Power Grid and Land Use Policy Options (\$550,000);
- Utility Workers Employees Policy Options (\$170,000);
- Engineering Options Review (\$97,000);
- Risk Assessment Guidelines (\$130,000).

Later, the program will contract epidemiology consultants to write articles on selected topics of EMF epidemiology.

For further information or for a copy of these RFPs, contact: Dr. Vincent DelPizzo, EMF Program, 5900 Hollis St., Suite E, Emeryville, CA 94608, Tel: (510) 540-3657, Fax: (510) 540-2673.



Now Available...

**The 1995 EMF
Resource Directory
from Microwave News**

Completely revised and updated for 1995, this indispensable guide lists hundreds of EMF contacts — researchers, utility representatives, consultants, state and federal government officials, citizens groups and more.

\$35.00, plus \$3.50 shipping, \$8.50 outside U.S.

**MICROWAVE NEWS • PO Box 1799 • Grand Central Station
New York, NY 10163 • (212) 517-2800 • Fax: (212) 734-0316**

Copenhagen Conference on Electromagnetic Hypersensitivity, held in May 1995, are now available. Edited by Drs. Jyrki Katajainen of the Department of Computer Science at the University of Copenhagen, Denmark, and Bengt Knave of the Department of Neuromedicine at the National Institute of Occupational Health in Solna, Sweden, the 138-page book is comprised of 23 papers. The paperback volume, which costs 210 Danish Kr. (approximately \$40), can be ordered by contacting: Danish Association for the Electromagnetically Hypersensitive, c/o Aase Thomassen, Lunden 1, Ålum, DK-8900 Randers, Denmark; (45) 86 46 61 14.

PEER REVIEW

Latest NIH Panel...Paul Strudler of NIH's Division of Research Grants in Bethesda, MD, convened a peer-review panel to examine EMF proposals, June 29-30. The members of the panel were: Drs. Deborah Cory-Slechta, University of Rochester, NY; Christopher Davis, University of Maryland, College Park; Amato Giaccia, Stanford University, Stanford, CA; David Grdina, Argonne National Laboratory, Argonne, IL; Sek-Wen Hui, Roswell Park Cancer Institute, Buffalo, NY; Howard Liber, Harvard School of Public Health, Boston; David McCormick, IIT Research Institute, Chicago; Steven Miller, SRI International, Menlo Park, CA; William Morgan, University of California, San Francisco; Keith Paulsen, Dartmouth College, Hanover, NH; Terry Pellmar, Armed Forces Radiobiology Research Institute, Bethesda, MD; Charles Polk, University of Rhode Island, Kingston; Joseph Roti Roti (chair), Washington University, St. Louis; Robert Ullrich, University of Texas, Galveston; and Peter Valberg, Gradient Corp., Cambridge, MA.

PEOPLE

Dr. **Richard Luben** of the University of California, Riverside, is the president-elect of the Bioelectromagnetics Society. He will take over from Dr. **Kjell Hansson Mild** of Sweden's National Institute of Occupational Health in Umeå, next year....**Frank Young** has taken a leave of absence from EnerTech Consultants in Campbell, CA, where he is a senior vice president, to go to Jilin City in the People's Republic of China. He will be teaching electrical engineering at the invitation of the Northeast China Institute of Electric Power Engineering....The NCRP has reorganized its activities into nine scientific program areas. Dr. **Tom Tenforde** has been appointed vice president for non-ionizing radiation....**Michael Withey** is the new president of Trial Lawyers for Public Justice....Dr. **John Osepchuk** has retired from Raytheon Co. He has set up Full Spectrum Consulting, based in Concord, MA. In addition, he will continue to serve as the acting chairman of SCC28 on Non-Ionizing Radiation Hazards.

RESOURCES

Review Paper...Drs. Eugene Goodman, Ben Greenebaum and Michael Marron have published "Effects of Electromagnetic Fields on Molecules and Cells," in the *International Review of Cytology*, 158, pp.279-338, 1995.

MICRO WAVE NEWS *Subscribe Now!*

A Report on Non-Ionizing Radiation

Please send me the following:

- 1-Year Subscription (6 issues) — \$285.00
(Outside the U.S., \$315.00)
- 6-Month Trial Subscription — \$150.00
(Outside the U.S., \$170.00)
- Sets of Back Issues — \$95.00/calendar year
1981-1994 (Outside the U.S., \$100.00)

Enclosed is my check for \$ _____
Prepaid Orders Only.
U.S. Funds or International Money Order, Please.

Name _____
 Organization _____
 Address _____
 City/State/Zip _____
 Country _____

**MICROWAVE NEWS • PO Box 1799 • Grand Central Station
 New York, NY 10163 • (212) 517-2800 • Fax: (212) 734-0316**

CLASSIFIEDS
