
Power-Line Static

*Debates rage over the possible hazards
of electromagnetic fields*

By CAROL EZZELL

Life is tough for researchers investigating the health effects of electromagnetic fields. Power companies berate them for scaring the public, and the public berates them for not being able to say for sure whether a high-current electrical wire running across the backyard might induce leukemia.

Even their experiments play tricks on them. Changes induced by electromagnetic fields are fickle phenomena — here one day, gone the next. And colleagues provide little solace. Anyone advancing an explanation for how these fields might affect biological systems can expect a grilling from every other researcher stalking such effects, plus the scorn of a raft of outside critics.

Yet these scientists soldier on — monitoring effects and generating hypotheses. In the past few months, new epidemiologic findings have strengthened the case for a link between electromagnetic field exposure and cancer. At the same time, several theories to explain such a link have gathered steam, fueling a fresh round of debate.

The controversy arose in 1979 when epidemiologist Nancy Wertheimer and physicist Ed Leeper observed that children living near high-current electric power lines appeared to face twice the leukemia risk of youngsters living farther away. They concluded that the extra cancers in this group resulted from exposure to the electromagnetic fields (EMFs) produced as electricity surged through the wires nearby (SN: 4/21/79, p.263). Wertheimer is with the University of Colorado Health Sciences Center in Denver, and Leeper works independently in Boulder.

The study launched a tirade of criticism — partly because Wertheimer and Leeper had estimated EMF exposures indirectly, by observing the configuration of power lines outside houses, and partly because the researchers knew which houses held the leukemia victims. But it also launched a new scientific discipline: the field of bioelectromagnetics.

One of the first studies to replicate the 1979 findings was led by David Savitz, an epidemiologist at the University of North

Carolina in Chapel Hill. In 1986, he reported results of a “blind” survey of approximately 500 Denver homes, half of which housed children with leukemia or other cancers. His team found that children living within 15 meters of lines carrying electricity from the power company’s substation to the neighborhood transformer faced five times the risk of all forms of cancer compared with children who lived farther away (SN: 2/14/87, p.107).

A spate of epidemiologic surveys conducted in the 1980s linked high EMF exposures to brain cancer, breast cancer and leukemia in adults. In 1982, for instance, Wertheimer and Leeper reported a slightly elevated incidence of breast cancer in women living near high-current power lines. Although a similar study in Britain failed to confirm these findings, a new report now links the EMF exposures of male utility workers with a statistically significant elevation in breast cancer risk. (Breast cancer, though far more common in women, strikes roughly 900 men each year in the United States.)

Researchers from 10 states and Norway monitored all cases of male breast cancer occurring between 1983 and 1987 in selected regions of the United States. The areas studied represented 15 percent of the U.S. population. Of the 320 cancer patients identified, 227 agreed to interviews about their job histories. The researchers found that 33 of the men had held jobs that may have involved high exposures to EMFs. Those jobs included electrician, telephone repairman, broadcast equipment operator and electrical engineer.

Using previously estimated exposure rates associated with each type of job, the investigators compared the occupational exposures of the 33 subjects with those of 300 healthy men, 26 of whom had held similar jobs. In the Aug. 15 *AMERICAN JOURNAL OF EPIDEMIOLOGY*, they report that men whose occupations potentially involved frequent exposure to EMFs had a breast cancer incidence nearly double that of men in other jobs. Men in electrical trades — such as power-line installers and power-plant operators — faced six times the usual risk.

“We observed that some occupational

groups of potentially exposed workers had a higher risk than others,” concludes study director Paul A. Demers of the University of Washington in Seattle. However, he cautions that this study cannot be used to predict the breast cancer risk of men in specific occupations because his team never directly measured the exposures of individual subjects. EMF exposures can vary dramatically, even within the same type of job, says Demers.

Another epidemiologic study, published in the December 22/29, 1990 *LANCET*, suffered from the same flaw. Tore Tynes and Aage Andersen of the Cancer Registry of Norway in Oslo tracked the health of nearly 38,000 Norwegian men from 1961 to 1985. They found 12 cases of breast cancer among electrical workers in this group — twice the number expected from the usual incidence among working Norwegian males. But Tynes and Andersen were not able to measure the actual exposures of the men they studied.

“These studies are indirect assessments of exposure,” notes Stanley S. Sussman of the Electric Power Research Institute (EPRI) in Palo Alto, Calif., a nonprofit group funded by the power industry to the tune of \$350 million annually. “They are interesting and suggestive of possible links [between EMFs and cancer], but they need to be followed up. Some of the research results might be just artifacts.”

Sussman directs EPRI’s \$6 million program to investigate health effects of electromagnetic fields. One study funded in part by his program used monitoring devices to sample representative EMF exposures of nearly 32,000 telephone linemen working for a New York company between 1976 and 1980. Researchers at the Johns Hopkins University School of Hygiene and Public Health in Baltimore chose this group of men because telephone lines are usually strung alongside electric power lines. In addition, most telephone switching offices used electromechanical switches — known to emit EMFs — until the 1980s, when they were replaced by computer-driven electronic switches.

By measuring the EMF exposures of a sample of men from each of four job categories, the Hopkins researchers, led by Genevieve M. Matanoski, found that cable splicers received the highest exposures, followed by central office technicians, who worked with the switches.

An examination of the state cancer registry revealed that two of the linemen in the study developed breast cancer; both worked as technicians at the telephone company’s central office. In the March 23 *LANCET*, the Hopkins researchers conclude that this represents a breast cancer incidence 6½ times greater than that of U.S. men in general. No other men employed by the company devel-

oped breast cancer, they note.

The researchers suggest that the technicians' elevated risk may trace to the rapid on-and-off switching of the EMF-emitting machinery in the central office. They note that a "fluctuating [EMF] exposure pattern was produced by the rapid switching environment," even causing the needle of a nearby directional compass to spin. Cable splicers and other linemen, in contrast, encountered continuous EMFs produced by the 60-hertz alternating current of the power lines.

Matanoski's team observed a similar trend in a study of leukemia among telephone linemen, which they described in June at a meeting of the Bioelectromagnetic Society in Salt Lake City. The researchers matched each of the 124 linemen who had died of leukemia between 1975 and 1980 with three healthy men of the same age who had worked for the company for the same amount of time. Although the cable splicers had the greatest EMF exposures, central office technicians working with old switching equipment again showed an increased leukemia risk, although the difference was too small to be considered statistically significant.

Even though these studies tie certain EMF exposures to cancer incidence, their authors concede the need for larger, more rigorous population surveys to confirm the correlation. The biological effect "being looked for — if it is there — is very subtle," asserts EPRI's Sussman. "[So] to do a really good study, you need very large populations."

Savitz and his colleagues began such an undertaking last year with roughly \$5 million in EPRI funds. The project—one of the largest epidemiologic studies ever attempted, according to Sussman—will attempt to calculate workplace EMF exposures for 130,000 electric utility workers, some of whom have died of brain cancer or leukemia since 1955.

To estimate typical exposures, the researchers are now correlating specific job tasks with individual exposure levels,

using data from hundreds of dosimeters worn by workers. Next, they plan to estimate each worker's exposure, based on his or her employment history. When completed in 1993, the investigation should possess the statistical strength to demonstrate or deny a causative connection between high EMF exposures and cancer, Sussman contends.

Skeptics will remain unwayed, however, until scientists provide a tenable explanation of how EMFs could affect biological systems.

EMF forces "are thousands of millions of times smaller than the force required to significantly change the motion of cell components, and millions of times smaller than the energies required to damage molecules," argues Robert K. Adair, a physicist at Yale University. Adair suspects that any mechanism tendered for EMF effects will likely come from "outside the scope of conventional physics," requiring exceptions to proven physical laws.

Yet a number of biophysicists, theoretical physicists and molecular biologists believe such a mechanism exists, and are busy constructing models to explain how EMFs could wreak biological havoc.

Arthur A. Pilla of the Mount Sinai School of Medicine in New York City thinks one explanation may lie in microscopic connections, or "gap junctions," between cells. At the recent Bioelectromagnetic Society meeting, he refuted physicists' previous calculations that voltage fluctuations caused by the normal molecular interactions across the wall of a typical cell would drown out any outside electromagnetic effects. Pilla's calculations suggest instead that gap junctions might permit such fields to "propagate exponentially," building a big enough punch to disrupt normal cellular processes and possibly induce a cancer.

Several research teams are now investigating whether calcium ions play a part in this scenario. Pilla's group reported at the meeting that EMFs caused bone-forming cells grown in culture dishes to take up calcium ions faster. Some researchers speculate that such ions could cause damage by zinging around within or between cells, a proposal called the cyclotron theory, after a magnetic apparatus used by physicists to accelerate particles in a circular path.

Ordinary household appliances generate larger overall EMFs than either long-distance, 500-kilovolt power transmission lines or the lower-voltage, local distribution lines that carry electricity into homes. But the appliance fields drop off roughly 5 meters away, while those emitted by power lines can extend hundreds of meters.

Others have observed EMF-induced changes in the functioning of genes. At the June meeting, a team led by Reba Goodman of Columbia University in New York City reported that exposing cultured cells to a 60-hertz field caused a three- to fourfold increase in the production of messenger RNA, which directs the assembly of proteins. And Ben Greenebaum of the University of Wisconsin-Parkside in Kenosha reported that bacteria stripped of their outer cell membranes made proteins faster when exposed to pulsed EMFs (SN: 7/6/91, p.15).

Still other researchers are looking for a hormonal effect, which they say would go a long way toward explaining the epidemiologic link between EMFs and breast cancer. In experiments with rats, Bary W. Wilson of Battelle Pacific Northwest Laboratories in Richland, Wash., found that EMFs slowed the pineal gland's secretion of melatonin, a hormone that directs the sleep-wake cycle. In 1987, cancer epidemiologist Richard Stevens of Battelle proposed melatonin suppression as a mechanism by which EMFs might cause breast cancer, based on previous experiments showing that melatonin inhibits mammary tumors in rats.

Another group at the June meeting reported that EMFs capable of making calcium ions resonate caused reduced melatonin secretion in rats. Because "pineal glands were affected directly, this strongly supports the assumption that organs may be affected by weak EMFs," asserts study director Alexander Lerchl of the Institute for Reproductive Medicine in Münster, Germany.

Paradoxically, the recent surge of epidemiologic and laboratory findings has derailed the Environmental Protection Agency's attempt to reach a conclusion concerning the health effects of EMFs (SN: 6/30/90, p.404). At the end of July, an outside review panel rejected EPA's draft report on the subject because it did not contain information from the new studies.

In written comments, the panel concluded that the draft report "will have to be in effect rewritten" to include findings reported since EPA staffers began working on the project in 1988. Although the panel members stated that they believe biological effects of EMFs "have been shown to occur [in earlier studies]," they found the evidence outlined in the draft report "insufficient to conclude that [EMFs are] carcinogenic."

EPA's Office of Health and Environmental Assessment now plans to produce a more up-to-date assessment, says William Farland, who heads the office. He predicts it will take a year to prepare a new draft report for the panel to review.

In the meantime, beleaguered researchers plow forward in their efforts to settle the issue once and for all. □

