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Research Council Panel Tries to End Controversy Linking EMFs with Cancer and Other Health Disorders

For the past 15 years, give or take a few, some scientists, journalists and concerned citizens have argued that exposure to electromagnetic fields (EMFs) produced by power lines and household appliances causes cancer and other health problems. This connection first appeared in the scientific literature in 1979 when an epidemiological study by Nancy Wertheimer, a psychologist who now works with the Department of Preventive Medicine at the University of Colorado, and Ed Leeper, a retired physicist, reported that children living close to 60 Hz power lines or electricity substations in the Denver area were 1.5 times more likely to develop leukemia than the expected rate for youngsters in the region. The study set off fears that it is dangerous, and in some cases deadly, to live near high-voltage power lines. In time, concerns arose that electric blankets, television sets, microwave ovens, personal computers and mobile phones may also be hazardous to human health.

Since the study by Wertheimer and Leeper, scientists in several industrialized countries have conducted hundreds of studies on the effects of EMFs. Most have been occupational studies of workers such as cable riggers whose work exposes them to EMFs. Other studies have examined whether people living near power lines or substations carry potentially greater risks of developing cancer or other disorders. Many found no health risks from ordinary EMF exposure, but others linked EMFs to a range of maladies, from miscarriages to breast cancer.

The issue was further polarized when Paul Brodeur wrote in *The New Yorker* about a high incidence of cancers among residents of Meadow Street in Guilford, Connecticut, who lived near a substation, and about children in Fresno, California, whose school was located near a substation. After Brodeur expanded his accounts into a book (*The Great Power-Line Coverup: How the Utilities and the Government Are Trying to Hide the Cancer Hazard*, Little Brown, New York, 1993), he was invited to discuss his horror stories on television and radio talk shows.

EMFs soon became a legal and economic nightmare. Millions of dollars

have been spent to reduce EMF levels in residential areas, citizen groups opposed new power plants and other electric facilities, and dozens of lawsuits were filed alleging illness or loss of property value because of nearby high-voltage power lines.

To address the burgeoning fears and help decide whether regulations were necessary, the Department of Energy and the Environmental Protection Agency, at the request of Congress, commissioned the National Academy of Sciences to provide definitive answers. It took a 16-member committee of the academy's National Research Council three years to respond. The exhaustive 300-page report appeared on 31 October, Halloween—an appropriate day, said wags, for such a frightful topic.

Reducing confusion 'out there'

The research council's report, according to Bruce M. Alberts, the academy's president, is intended to remove or at least reduce "the vast amount of confusion that there is out there." After reviewing more than 500 studies, the panel concluded that at very high levels EMFs can have serious biological effects. These include disruption of chemical signaling between cells in cultures, and inhibition of melatonin production and promotion of bone healing in animals. But the panel concluded that at the levels measured in residences, EMFs were just too weak to cause adverse effects on cells or animals and certainly not on humans. In fact, the committee declared that there is "no conclusive and consistent evidence" that ordinary exposure to EMFs in the home can "produce cancer, adverse neurobehavioral effects or reproductive and developmental effects."

Still, the research council's report is not expected to end the controversy. The only possible cause for concern, the panel found, was a "weak but statistically significant" association between proximity to high-voltage electrical transmission lines and childhood leukemia, a very rare disorder.

Like the study by Wertheimer and Leeper, some of the other research papers have indicated that children who live near major power lines seem to have a higher rate of leukemia than

children in other neighborhoods, "although the causative factor responsible for that statistical association has not been identified," the committee observed. In very general terms, the apparent increase in leukemia rates is found around homes within 50 yards of an overhead transmission line with six wires—the sort that carries 115 000 to 500 000 volts. The kinds of overhead power lines with three or fewer wires customarily found in residential neighborhoods are not transmission lines but are considered distribution lines not usually associated with cancer or other health risks.

Yet when researchers have measured the magnetic fields in homes where sick children live, they have found no correlation between the instrument readings and the incidence of cancer and only a very weak correlation between the types of outside transmission lines and the EMF strength inside. When scientists have measured fields inside the homes of children with leukemia, the results, said the report, "have been inconsistent and contradictory and do not constitute reliable evidence of an association." This suggests that the increase of cancer rates among children in homes with high "wire codes"—an estimate of household EMFs based in part on the distance to power lines—"may be the result of factors other than magnetic fields that are common to houses with the types of external wiring identified with the disease."

It turns out that wire codes are not a good indicator of actual fields in the home, says the committee. The causes of childhood leukemia may in fact be due to other factors, such as air pollution, since high wire codes tend to be near heavily traveled roads, or in older buildings with frayed electrical systems or around grass and foliage sprayed with herbicides. "Data are seldom sufficient to provide a definitive answer to the possible health effects of a physical or chemical agent in the environment," said the panel's chairman, Charles F. Stevens, a professor at the Salk Institute in La Jolla, California, and a research scientist with the Howard Hughes Medical Institute located near Washington, DC. Stevens said at a press briefing on the report

that more research is needed to identify what factors—if not EMFs—may be causing increased rates of leukemia.

Though all the panelists on the committee signed the report, three took the unusual step of issuing statements arguing that the debate over health effects was hardly over. "It is true that there is not enough evidence to convict EMFs beyond a reasonable doubt, but there is every reason to view them as a prime suspect," said Louis Slesin, editor of *Microwave News* and a committee member. In a letter to *The New York Times*, Richard A. Lubin, an epidemiologist at the University of California, Riverside, and Daniel Wartenberg of the Robert Wood Johnson Medical School in Piscataway, New Jersey, both panelists on the research council study, observed that the report "concluded that there is a small (1.5-fold) and valid excess of childhood leukemia in households near groups of power lines. Where the real debate lies is whether this association is due to electromagnetic fields or some other factor. . . . We hope some of the continuing research on the epidemiology and basic science of this question will help clarify the issue."

'Exaggerated beyond reason'

Such statements differ only in tone from the conclusion reached by William Bennett, professor of engineering and applied science and professor of physics at Yale University, who took part in a study of EMFs conducted in 1992 by Oak Ridge Associated Universities. Writing in *PHYSICS TODAY* in April 1994 (page 23), Bennett protested that the dangers to human health from low-level EMFs were "exaggerated beyond reason." His understanding of the relationship was based, Bennett stated, "on considerations ranging from the underlying physics to the inconsistent epidemiological data and lack of concrete biological results." He went on to say, "It is appalling that close to a billion dollars has already been spent on this problem." Even so, he suggested that further research ought to proceed, though he saw no need for "any sort of crash program."

This was followed by a resolution of the council of the American Physical Society, issued the following April (see *PHYSICS TODAY*, July 1995, page 49). After reviewing the scientific literature, as well as reports by various scientific panels, the APS council stated that it could find "no consistent, significant link" between power line fields and cancer. "No plausible biophysical mechanisms for the systematic initiation or promotion of cancer by these power line fields have been identified. Furthermore, the prepon-

derance of the epidemiological and biophysical/biological research findings have failed to substantiate those studies, which have reported adverse health effects from exposure to such fields. While it is impossible to prove that no deleterious health effects occur from exposure to any environmental factor, it is necessary to demonstrate a consistent, significant and causal relationship before one can conclude that such effects do occur. From this standpoint, the conjectures relating cancer to power line fields have not been scientifically substantiated," said the APS resolution. After referring to the huge sum of money spent on mitigation and litigation over EMFs, the resolution concluded that "the burden of cost placed on the American public is incommensurate with the risk, if any."

Notwithstanding the findings by the research council's panel, the APS council and others, the controversy does not

appear to be settled. Two recent studies, one by Britain's National Radiological Protection Board and another by the Oak Ridge Associated Universities, conducted for the White House Office of Science and Technology Policy and the Department of Labor, have reviewed the galaxy of scientific papers on EMFs and concluded that the issue is long on alarm and short on meaningful research. Other groups are engaged in reviews of the subject: The Environmental Protection Agency would like to decide whether to seek regulatory controls on power lines near residences and office buildings, but has delayed its study in part for budgetary reasons. Meanwhile, the National Institute of Environmental Health Sciences, which together with the Energy Department conducts a \$65 million EMF research project, is scheduled to issue a report to Congress in mid-1998.

IRWIN GOODWIN

Whither Physics? NRC Panel Initiates New Survey in Era of Limits

By almost any standard, the past half-century has been a golden age of physics in the US. But in the 1990s physics confronts a paradox: Reduced expectations for funding and growth are occurring alongside greater opportunities for productivity and discovery. This disjunction has led the Board on Physics and Astronomy of the National Research Council, which conducts studies on behalf of the National Academies of Sciences and Engineering, to undertake a new diagnosis of the health of the entire discipline.

The latest examination follows by a decade the last one, named "Physics Through the 1990s." That survey did not foresee some of the problems that would soon arise. When it was published in 1986 (see *PHYSICS TODAY*, April 1986, page 22), the survey was intended to be a plan for the next decade—intellectually and experimentally. But in the early 1990s, it became abundantly clear that physics was under stress—beset by shrinking funds for basic research in government and industry, by more complex and costly research instruments and facilities, and by fears that fewer students would choose physics for their life's work. No wonder, then, that the new survey bears the title "Physics in a New Era."

The three previous physics surveys prepared by committees of the research council, beginning with one completed in 1966 by a panel headed by George E. Pake, then at George Washington University in St. Louis, concentrated

mainly on documenting the achievements of physics and describing the requirements for continued progress. The Pake report, like the surveys that followed in 1972, under the chairmanship of D. Allan Bromley of Yale University, and in 1986, led by William F. Brinkman of AT&T Bell Labs, assumed that physics is a coherent and fast-moving enterprise whose values, goals and practical applications are readily appreciated by government and society. Justification for the financial support of physics was taken for granted, in part because physicists had helped win World War II with numerous innovations, such as the proximity fuze, radar, sonar and the nuclear bomb. In the years that followed, physics flourished and so too did the nation's economy, with a stunning proliferation of technologies based on physics research.

By the early 1990s, dire warnings were sounded about the perils facing physics. Some predicted that the red ink of the Federal debt would overflow into the government's R&D budgets. Among the first to sound off was Erich Bloch, who as director of the National Science Foundation cautioned that financial pressures on Federal programs would limit research investments in the decade of the 1990s. And when the period of steady-state budgets ends, the decline that follows will increasingly threaten the health of research communities into the next century, Bloch declared. Soon afterward, Leon Lederman, Fermilab's director