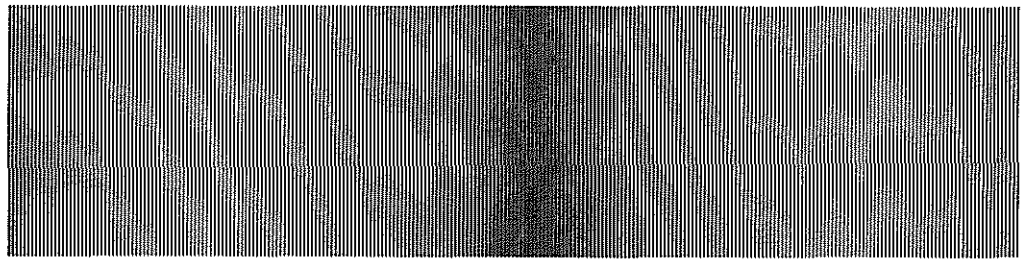


MICRO WAVE NEWS



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A Report on Non-Ionizing Radiation

September/October 1992

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Swedish Officials Acknowledge EMF—Cancer Connection

New Epi Studies Prompt Policy Shift Mitigation Strategies Being Adopted

On September 30, Sweden's National Board for Industrial and Technical Development, NUTEK, formally announced that from now on it "will act on the assumption that there is a connection between exposure to power frequency magnetic fields and cancer, in particular childhood cancer."

The new policy was prompted by two major epidemiological studies, released the same day, which add support to the proposition that exposures to weak electromagnetic fields (EMFs) at home and on the job contribute to the development of cancer. This is the first time a national government has recognized the EMF—cancer link.

Jaak Nöu, the director of NUTEK's Department of Electrical Safety, told *Microwave News* that the new policy will apply primarily to children. "We don't yet consider the link proven for adults—this will have to wait for detailed investigations from around the world."

In the residential study, Dr. Anders Ahlbom and Maria Feychting of the Institute of Environmental Medicine at the Karolinska Institute in Stockholm found that children exposed to average fields of 3 mG or more in their homes

U.S. Congress Okays \$65 Million EMF Research Plan, see p.2.

had close to four times the expected rate of leukemia. The link to cancer among adults was weaker than for children. "The results provide support for the hypothesis that exposure to magnetic fields increases the risk of cancer," they concluded.

The occupational study by Dr. Birgitta Floderus and coworkers at the Department of Neuromedicine at the National Institute of Occupational Health (NIOH) in Solna, a suburb of Stockholm, showed that men exposed to similar levels of magnetic fields at work had three times the expected incidence of chronic lymphocytic leukemia (CLL).

The studies, which used sophisticated exposure assessments, go a long way toward resolving some of the ambiguities that have prompted doubts about the EMF—cancer link. Most notably, they identify dose—response relationships between cancer and EMF exposure and may explain why previous childhood cancer studies failed to establish a link with measured magnetic fields.

NUTEK will soon begin work on EMF exposure regulations for new homes near power lines and for all new electrical facilities, which Nöu predicted would take about six months to complete. He said that the standard

(continued on p.12)

« Power Line Talk »

The Health Effects Institute's much-delayed EMF research plan will be released by the end of the year, according to Acting President Dr. Charles Powers. "HEI is never going to step into a scientific area until its board and its scientific advisers have determined that they have something to contribute," Powers told *Microwave News*, adding that HEI had not promised the plan by a certain date. Dr. Andrew Sivak, who resigned last spring from his position as president of HEI, had originally predicted that the report would be completed by November 1991. After HEI's board reviewed a draft, however, an extensive rewrite was undertaken (see *MWN*, N/D91). "HEI is managing the creation of the report directly now," Powers explained, and Cambridge-based Gradient Corp., which coordinated the work under Sivak, is no longer involved. Dr. Joe Brain of Harvard University's School of Public Health now heads the Electric and Magnetic Fields Research Planning Committee; the former chair, Dr. Richard Setlow of Brookhaven National Lab, remains a member of the committee. HEI began its work on EMFs in 1991 with funding from EPA, which has been considering the creation of a public-private research program (see *MWN*, M/A91, J/A91 and S/O91). The assessment of possible research directions "will be useful irrespective of any additional role HEI may play," Powers said.

« « » »

A 230 kV Philadelphia Electric Co. (PECO) power line should not be energized until the Pennsylvania Public Utility Commission (PUC) sets EMF exposure standards, PUC administrative law judge Herbert Smolen ruled on August 19. Smolen said he made the decision in spite of the fact that "no causal connection between biological effects of EMFs and harm to human health has been scientifically proven or disproven." The PUC had originally approved the utility's plan to upgrade the line from 138 kV in 1990 (see *MWN*, M/J91). Residents and citizens groups later petitioned to have the case reviewed. The PUC has no plans to regulate exposures, according to spokesman John Frazier. On September 14, PECO filed an exception to Smolen's decision—a move that will force the full commission to review and vote on the case, Frazier said. "Smolen couldn't find any adverse health effects, and then he turned around and said the line shouldn't be energized," argued PECO spokesman Bill Jones. "Why endanger service to so many people when we are well within Florida and New York standards?" Jones further criticized Smolen's decision for being "disastrous to economic development" in the state and said that it would set "an extremely dangerous precedent." Even though the commission may decide to reverse Smolen's ruling, nearby residents have claimed a victory. "It's a terrific decision," Dorothy English of Parents Against an Unsafe Environment (PAUSE) told *Microwave News*. "We have no EMF exposure standards in Pennsylvania and it's great that the PUC recognizes that maybe it's time for a change." According to Jones, EMFs would measure about 40

mG at the edge of the right-of-way along the 12.8 mile line, which runs between two towns in Bucks and Montgomery Counties. Florida and New York have set right-of-way magnetic field limits for 230 kV lines at 150 mG and 200 mG, respectively (see *MWN*, M/A88, M/A89, J/F90, M/A90 and S/O90). Interestingly, the Florida standard was set after the state's Siting Board denied the Florida Power Corporation a permit to build a 500 kV line, pending the development of magnetic field exposure limits (see *MWN*, M/A86). The Pennsylvania PUC will probably meet to vote on the case at the end of the fall, Frazier said.

« « » »

A subsidiary of the Irish Electricity Supply Board (ESB) and Dick Roche, a member of the Irish parliament, have engaged in a stinging exchange over whether the subsidiary is fit to investigate a possible EMF-cancer link in North Dublin, since the ESB is involved in long-standing disputes over the siting of its power lines (see *MWN*, S/O87 and M/A89). "There is a well-accepted principle that one cannot be the judge in one's own case," quipped Roche in a July 10 letter to Gerry Breen, managing director of ESBI Engineering Ltd.—a subsidiary of the ESB, Ireland's Dublin-based national utility. Breen had written to Roche saying that he took "grave exception" to remarks Roche had made that appeared in the *Irish Independent*, because they implied that his company lacked "professionalism

Congress Approves \$65 Million EMF Research Program

On October 8, Congress passed a far-reaching national energy bill that, among many other provisions, authorizes a \$65 million electromagnetic field (EMF) research and public information program. As we went to press, the President was expected to sign the bill.

When the legislation emerged from a House-Senate conference committee, the Department of Energy (DOE) had again been put in charge of the program and been given specific responsibility for engineering research. The National Institute of Environmental Health Sciences (NIEHS) retained responsibility for all health effects research and the communications component of the program. The original version of the legislation gave the entire effort to the DOE, but it was transferred to NIEHS in the bill the House passed last May (see *MWN*, J/F92, M/A92 and M/J92).

The measure provides for \$13 million in each of the next five years, of which up to \$1 million is for communications. Half of the funds are to come from nonfederal sources.

A full report on the legislation will appear in our next issue.

and ethical standards." He refuted Roche's claim that it would be difficult for an ESB subsidiary to give an "objective appraisal" of its parent company. ESB Engineering has been asked by a state medical officer to assist in measuring EMFs from power lines in North Dublin. Roche represents County Wicklow, which includes North Dublin, in parliament.

«« »»

The California Energy Commission (CEC) should take steps to ensure that public exposures to power line EMFs do not grow in the future, according to a report by CEC Staff Toxicologist Dr. Obed Odoemelam—but Odoemelam also recommends that no action be taken to lower EMFs from their present levels. Reducing magnetic fields "would mark a major departure from the existing electric field-based approaches to field control," the report states. Odoemelam reasons that there is not enough scientific evidence to warrant further mitigation policies. "Changes in field control should be instituted only after establishing the cancer-causing effects of magnetic field exposure with a high level of certainty," he writes. The 27-page report provides a brief overview of laboratory, cellular and epidemiological studies on the effects of EMFs and concludes that they are often unreliable or contradictory and permit only "uncertain interpretations." The report is careful to note, however, that the possibility of "significant biological effects cannot be discount-

ed," and recommends that the CEC continue to support related research. The commission has not yet taken a position on the issue, nor has it announced plans to do so, CEC Executive Director B.B. Blevins told *Microwave News*. To order a copy of *High-Voltage Transmission Lines: Summary of Health Effects Studies*, send \$2.10 and a self-addressed mailing label to: California Energy Commission, Publication Unit, 1516 Ninth St., MS-13, Sacramento, CA 95814. Refer to publication No. P700-92-002.

«« »»

Dr. Charles Polk of the University of Rhode Island is organizing a mini-symposium, "Where Are the Thresholds for Biological Effects of Non-Endogenous Low Frequency, Low Intensity EMFs," at the 14th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, to be held in Paris, France, on October 29-November 1. Among the scheduled speakers are Drs. Friedemann Kaiser, Ken McLeod, Jerry Phillips and Bill Pickard....And Dr. Morando Soffritti of the Institute of Oncology in Bologna, Italy, is planning a half-day conference, *ELF EMFs and Cancer: A Priority for Research* on November 23 in Carpi, which is near Bologna. Dr. Anders Ahlbom, Dr. Gary Boorman, Paul Brodeur, Dr. Cesare Maltoni and Dr. Sam Milham have been invited to give presentations.

NIEHS Awards IITRI \$8 Million for Animal Studies

The National Institute of Environmental Health Sciences (NIEHS) has signed an \$8,292,397 contract with the Chicago-based IIT Research Institute (IITRI) for a study of the possible carcinogenic and reproductive effects of 60 Hz magnetic fields on laboratory animals. The effort marks the largest set of studies ever attempted by a health agency in the U.S.

In the cancer study—which will use more than 2,000 rats and mice—animals will be exposed to continuous 20 mG, 2 G or 10 G magnetic fields, or to intermittent 10 G magnetic fields for up to two years. Researchers will use 100 animals in each exposure group, instead of the usual 50, to "give greater sensitivity in detecting marginal effects of exposure," said Dr. Gary Boorman, project officer for the study and chief of NIEHS' pathology branch.

Three generations of animals will be monitored in the reproductive study. Number of litters, number and percent of live pups per litter and mean body weight of live offspring of exposed parents will be checked. The offspring will then be bred, and their offspring will be similarly observed.

The 56-month contract, signed on August 10, will be administered by the National Toxicology Program (NTP), which coordinates research for the Department of Health and Human Services (DHHS); NIEHS is a part of the DHHS. Construction

of a \$2 million animal exposure system began in September, and the experiments will begin next spring, Boorman said. The National Institute of Standards and Technology (NIST) will confirm that the exposure setup is correct, Boorman said, noting that NIST's validation "will add to the credibility of the study."

For a copy of the *Statement of Work for the Conduct of Studies to Evaluate the Toxic and Carcinogenic Potential of 60 Hz Magnetic Fields in Laboratory Animals for the National Toxicology Program*, contact: Thomas Hardee, NIEHS, Contracts and Procurements Management Branch, PO Box 12874, Research Triangle Park, NC 27709, (919) 541-0429. Refer to contract No. N01-ES-25351. For more on the study, see *MWN*, S/O90.

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Utility Group Develops Home Measurement Protocol

In an effort to help utilities respond to customers' requests, a task force of utility engineers is developing a protocol for EMF measurements. "Power companies all over the country are taking readings in different ways," said Peter Jump, a spokesman for the Edison Electric Institute, a member of the task force. "We wanted a standard way of doing them."

The protocol will help small utilities that might not have the resources to develop expertise in measuring EMFs, as well as the larger companies that are confronted with growing numbers of requests for information, explained Kate Maracas, director of the task force, formally known as the National EMF Measurement Protocol Group (NEMPG). Maracas is an environmental engineer at the Salt River Project, a publicly owned utility based in Phoenix. She said the group also plans to produce a training video to accompany the protocol, which should be completed by the spring of 1993.

The Institute of Electrical and Electronics Engineers (IEEE) Magnetic Fields Task Force—a subcommittee of IEEE's AC Fields Working Group—has been working closely with NEMPG in developing the standard, Maracas said. The IEEE group will publish its own protocol for power frequency fields in January.

NEMPG was formed last September. Its members include utility representatives and three utility trade organizations: the American Public Power Association, the Edison Electric Institute and the National Rural Electric Cooperative Association.

Legal Notebook

PG&E Worker's Family Files EMF Claim

The family of a former Pacific Gas & Electric (PG&E) maintenance worker filed a wrongful death claim against the northern California utility on August 10, charging that the electrician's fatal leukemia was caused by his on-the-job exposure to EMFs. John Lacey, who died in February at the age of 40, had worked at various substations in the San Francisco Bay area from 1971 to 1981; his leukemia was diagnosed in 1990, according to his attorney, Flora Chu of the San Francisco firm of Hawes & Chu. Chu said that she might also bring a personal injury suit on the family's behalf.

Lacey's duties for PG&E included inspecting and reading meters on electrical equipment and checking devices in underground vaults, according to a stipulation of facts signed by Chu and PG&E's lawyer, Carl Allen. EMFs from switching devices in such vaults can reach 37 G, according to measurements commissioned by the International Brotherhood of Electrical Workers (IBEW) Local 1245, based in Walnut Creek, CA. IBEW's Landis Marttila told *Microwave News* that union members are concerned about EMFs and that they are considering assembling a cancer registry for utility workers.

PG&E is reviewing Lacey's job records and medical histo-

EMF Measurement Guides

Dr. Granger Morgan of Carnegie Mellon University has written a new booklet, *Measuring Power Frequency Fields*, which offers advice on EMF surveys in the home and workplace. The guide is for individuals who ask experts to take readings for them or who plan to take measurements themselves. Morgan and his colleagues, including Drs. Jack Adams, Baruch Fischhoff and Indira Nair, are also working on a second booklet, which is meant to be consulted after a survey has been done. *Making Sense out of Measurements of Electric and Magnetic Fields* offers ways of interpreting the findings and reviews EMF health risks. The second booklet will be available in a couple of months.

Carnegie Mellon has distributed more than 100,000 copies of its original booklet, *Electric and Magnetic Fields from 60 Hertz Electric Power: What Do We Know About Possible Health Risks?* since it was first published in 1989.

To order the measurement guides, contact: Department of Engineering and Public Policy, Carnegie Mellon University, Pittsburgh, PA 15213. Prices were not available as we went to press.

ry, according to PG&E spokesman Scott Blakey. It is too early in the investigation to say "anything meaningful" about the case, Blakey said. In March, a Washington State agency rejected a claim that a Seattle City Light electrical worker's death from leukemia was caused by his exposure to EMFs (see *MWN*, M/J92). That decision has been appealed.

A Change in the Course of EMF Litigation?

Mounting evidence of a potential link between EMFs and health hazards is likely to change the course of EMF personal injury litigation, writes Kristopher Brown in the March 1992 issue of the *Boston University Law Review*.

Owners and manufacturers of equipment that generates EMFs will find it increasingly difficult to argue that they were unaware of the risks associated with EMFs and, as a result, they will face a greater threat of liability under negligence and strict product liability laws, Brown predicts.

Meanwhile, plaintiffs will continue to face the difficult task of proving causation—the connection between exposure to EMFs and injury—as scientific evidence on the subject remains inconclusive and courts may decide not to admit EMF expert testimony, further hindering plaintiffs' efforts, according to Brown. Judges have rejected such testimony in the past due to a lack of scientific evidence (see, for example, *MWN*, J/A92).

"The EMF debate is not likely to be resolved in the near future," Brown concludes, "[but] unless serious consideration is soon given to these complex questions, EMF personal injury litigation is destined to become a legal quagmire."

Are Navy Communications Towers Responsible for Hawaiian Childhood Leukemia Cluster?

A cluster of childhood leukemia cases near a Navy submarine communications facility in the Waianae Coast section of the island of Oahu, HI continues to defy attempts to pinpoint a cause. But recent reports by the Hawaii Department of Health (DOH) and by the U.S. Environmental Protection Agency (EPA) add evidence that the cluster, first investigated in the mid-1980s, was not due to chance and might be related to radiofrequency (RF) radiation emissions from the Navy facility, which is known as Lualualei.

The DOH investigation, a case-control study of 14 children who were diagnosed with leukemia between 1977 and 1990, found that the incidence of the disease was higher among children who lived closer to Lualualei. This finding was not statistically significant, but elevated odds ratios were identified for all six variables the researchers used to assess proximity to Lualualei. The DOH report concluded that there may be a "weak association" between proximity to the transmitters and the inci-

dence of leukemia but cautioned that, "We do not have enough knowledge to link the two causally."

"I don't think the cluster is a chance event," Dr. Gertraud Maskarinec, coauthor of the DOH report, told *Microwave News*. She added that childhood leukemia rates in the area have been normal in recent years.

Overall, the 14 cases constitute a statistically significant doubling of the expected number, based on childhood leukemia rates for the state. But the researchers found that the greatest cause for concern was in a three-year period: seven children were diagnosed with leukemia from 1982 to 1984. "These...cases are unusual in several respects," the report explains, because:

- Five of [the seven] were acute non-lymphocytic leukemias, while three out of four childhood leukemias statewide are of the lymphocytic type.
- Six of the cases were girls, while childhood leukemia is usually somewhat more common in boys than in girls.
- Four of these girls were between nine and twelve years old at diagnosis, [while the] peak age of onset for childhood leukemias is around three years.

Similar Cluster Near U.S. Navy Transmitters in Scotland

A cluster of childhood leukemia has also been documented in Thurso, on the north coast of Scotland, near a U.S. Navy communications facility. This cluster has prompted several studies—primarily examining ionizing radiation—which have yielded few answers. No detailed investigation of RF radiation from the Navy complex, in Forss, has yet been done.

An extensive analysis of a possible connection with ionizing radiation from a nearby nuclear fuel reprocessing plant at Dounreay was completed in 1988 by the Committee on Medical Aspects of Radiation in the Environment (COMARE), a government-sponsored panel. The report concluded that the elevated cancer rates could not be linked to radiation from the nuclear facility: "Conventional dose and risk estimates suggest that neither authorised nor accidental [radioactive] discharges could be responsible."

But the report also argued that the cluster was not a chance occurrence. Between 1979 and 1984, six children developed leukemia—a statistically significant increase. The panel noted that, "These are extreme results and this is a remarkable observation."

A follow-up study by the Scottish Health Service, published in 1991, failed to establish a link between the children's leukemia and their fathers' exposure to nuclear radiation at the Dounreay plant.

The Navy's Forss transmitter facility is located about halfway between the Dounreay nuclear station and the town of Thurso.

A number of possible causes for this cluster have been raised: RF radiation from Lualualei; benzene from used motor oil; pesticide-contaminated milk; some other, unknown carcinogenic chemical; or exposure to a carcinogen in combination with RF emissions from Lualualei.

Dr. Bruce Anderson, DOH's deputy director for environmental health administration, said in an interview that he is less concerned about the Lualualei transmitters than he is about possible exposure to carcinogenic chemicals, such as benzene. "There was a lot of used motor oil being brought to that community," he said, explaining that a waste-oil hauler had operations there. Rather than disposing of the oil, the hauler sprayed it on roads to keep dust down and gave large amounts to area residents, some of whom used it on their farms. The waste oil, found in 55-gallon drums on property throughout the area, is the object of a DOH-led cleanup effort begun in 1991.

DOH researchers considered the waste oil problem but did not analyze it in the case-control study. "I cannot think of a practical way to assess exposure," Maskarinec said.

The possibility that emissions from Lualualei could be harmful has worried nearby residents for more than a decade. In 1982, reacting to their concerns, the Navy measured radiation within the boundaries of its facility and declared that there was no health risk (see *MWN*, J/A82). By 1985, however, the unusual occurrence of childhood leukemia had been noticed and was brought to the attention of the Cancer Research Center of Hawaii, which ran a preliminary investigation; the center recommended further study, including measurements of RF exposures (see *MWN*, M/J87). In the summer of 1990, U.S. Sen. Daniel Akaka (D-HI) and a state legislator held separate hearings that addressed Lualualei. Shortly thereafter, the DOH

EPA May Return to RF/MW Limits

The Environmental Protection Agency (EPA) is considering resuming work on setting safety limits for human exposures to radiofrequency and microwave (RF/MW) radiation. EPA stopped developing the limits—commonly known as RF/MW guidance—in 1988.

"We are currently evaluating the need for the guidance," Margo Oge, the director of EPA's Office of Radiation Programs (ORP), announced at a Senate hearing on police radar on August 10 in Washington (see p.7). EPA is also planning to hold a conference on the health effects of RF radiation, she said.

Following the hearing, Sen. Joseph Lieberman (D-CT) urged EPA Administrator William Reilly "to take up the development of [the RF/MW] guidance again." This was the second time this year that EPA was asked to return to the question of RF/MW exposure limits. Accompanying its review of the agency's cancer report, EPA's Science Advisory Board recommended that the agency "complete its efforts with regard to [RF/MW radiation] and issue exposure guidelines independent of present issues pertaining to lower frequencies" (see *MWN*, J/A91 and J/F92).

At the end of September, Marty Halper, the director of ORP's Radiation Studies Division, told *Microwave News* that the EPA conference, which is tentatively scheduled for April, will address RF/MW bioeffects and cost-benefit issues. "If those at the conference perceive a need for the guidance, we'll do it," he said.

In an interview, Oge said, "It will be important for the agency to finalize its work."

EPA began work on the guidance in the late 1970s and was set to propose a 100 $\mu\text{W}/\text{cm}^2$ limit for 30-300 MHz radiation in 1984 when the agency's policy office forced a delay (see *MWN*, Jun84 and J/A84). EPA continued to work on the standard but abandoned the effort in 1988 (see *MWN*, J/A86 and S/O88).

began its investigation, asking EPA to measure the RF radiation near the Navy facility (see *MWN*, S/O90 and J/F91).

The RF emissions from Lualualei are uncommon, since the Navy transmitters are used for long-distance communications with submarines and are found in only three other U.S. communities, according to EPA. The Navy uses equipment operating in the very low frequency (VLF), low frequency (LF) and high frequency (HF) ranges (see box p.7).

"VLF electric and magnetic fields were studied much more intensively than fields at other frequencies because of the high power of this transmitter," according to the report, which was prepared by Edwin Mantiply of EPA's National Air and Radiation Environmental Laboratory in Montgomery, AL. The VLF transmitter operates continuously at 23.4 kHz, with an output of

512 kW. Mantiply also sampled electromagnetic fields from power lines at several outdoor locations in the community.

Mantiply found electric field strengths as high as 82 V/m from the VLF transmitter, and magnetic field strengths as high as 99 mA/m, in an open area just outside the facility. In a telephone interview, he said that in the adjacent communities "people do get exposed to 80 V/m outdoors," adding that, "you see 60 V/m in wide areas." But the EPA report was not designed to assess typical exposures, and no measurements were taken indoors or near the residences of those who developed leukemia. "The object was to gain some understanding of field levels in the community rather than conduct a detailed exposure assessment," the report states. The results are generally consistent with the measurements the Navy made in 1982.

Some significant questions about this cluster remain unanswered. For example, the DOH investigators noted in their report that four of the children with leukemia lived in Quonset huts—WWII surplus buildings which have corrugated metal roofs in a half-cylinder shape. There are several hundred such buildings used as homes in the area. Maskarinec said she could reach no conclusions about this finding. "I'm tempted to think it's a surrogate for something else," she said—perhaps time spent outdoors, since Quonset huts are presumably less comfortable than other homes, or exposure to some toxic chemical or metal. She said that she would expect these buildings to shield their occupants against radiation from Lualualei but added that, "It would be a good idea to measure there."

EPA's Mantiply said the Quonset huts would affect RF exposures. "They could be your best shield or your worst nightmare," he said. "It all depends on how they are built." If the metal roof is well grounded, it will function as a shield. If it is not, he explained, it will work much like an antenna and could "be a strong source of VLF current" for someone who came in direct contact with it. He emphasized that he had not investigated these buildings.

The DOH investigators also explored the possibility that something unusual had happened at the Lualualei facility to trigger the leukemia outbreak that occurred from 1982 to 1984. They searched a newspaper index and found that maintenance problems and disrepair led to the firing of the maintenance contractor at Lualualei in early 1981, but they were hesitant to draw any conclusions from this. "One hypothesis about the effects of electromagnetic radiation suggests intermittent or irregular exposures may be more harmful than continuous exposures," the report states. "However, a real association between the leukemia cluster and the events in 1981 appears unlikely because of the short incubation period."

Another episode from the early 1980s was not addressed by the DOH. In January 1982, milk supplies on the island of Oahu were found to have been accidentally contaminated with heptachlor, a pesticide that had been sprayed on pineapple leaves used as feed for dairy cattle. The tainted milk was sold for at least 57 days before a general recall was begun, according to a report in *Science* (217, pp.137-140, July 9, 1982). Several experts "are concerned that infants in particular will suffer a heightened risk

of leukemia or liver disorders," the article stated.

DOH's Anderson said he does not believe that the heptachlor contamination could be associated with the cluster since "the milk problem was an island-wide problem" and the cluster just appeared in the Waianae Coast section.

Several recent studies have suggested that electromagnetic radiation can act synergistically with known chemical tumor promoters to accelerate the development of cancer (see *MWN*,

J/A89, N/D90 and J/A91). None of these studies has specifically addressed VLF radiation, however, nor did the DOH look into such combined effects. In the mid-1980s, the DOH found that people living next to radio and TV broadcast towers in Honolulu had elevated rates of cancer (see *MWN*, M/J87).

If a child had ever lived within 2.2 miles of the Lualualei facility, or lived within 2.6 miles just before diagnosis or at birth, the leukemia risk was more than double that of the controls. Residence within 2.6 miles of the transmitters in 1981 yielded a risk more than three times that of the controls, as did a summary index used to assess proximity to Lualualei. A history of cancer in the family also showed an association with the incidence of leukemia. None of the findings in the case-control study achieved statistical significance.

The DOH report, *Investigation of Childhood Leukemia on the Waianae Coast 1977-1990*, is available from: Hawaii DOH, Communication Office, 1250 Punchbowl Street, Honolulu, HI 96813, (808) 586-4442. The EPA report, *Measurements of Electric and Magnetic Fields in the Waianae, Hawaii Area* (400R-92-009, July 1992), is available from: EPA, National Air and Radiation Environmental Laboratory, 1504 Avenue A, Montgomery, AL 36115, (205) 270-3400.

RF Radiation from Lualualei

The following are the maximum field strengths as measured by EPA outside the boundaries of the Lualualei Naval Radio Transmission Facility:

	Electric Field	Magnetic Field
VLF (23.4 kHz)	82 V/m	99 mA/m
LF (146.1 kHz)	0.5 V/m	0.9 mA/m
HF (3-30 MHz*)	8.8 V/m	22 mA/m

From: EPA, *Measurements of Electric and Magnetic Fields in the Waianae, Hawaii Area*, 1992.

* Various frequencies.

Congress Directs NIOSH To Study Police Radar-Cancer Link

The U.S. Congress has directed the National Institute for Occupational Safety and Health (NIOSH) to begin an epidemiological study of the possible link between police radar use and cancer.

At a Senate hearing in August, scientists, radar manufacturers, federal health officials and police officers all voiced support for a federal study. Such an effort was first proposed by Sen. Christopher Dodd and strongly promoted by Sen. Joseph Lieberman—both Democrats from Connecticut.

"Senator Dodd and I are going to stick with this until we get some answers," Lieberman said at the August 10 hearing of the Senate Governmental Affairs Committee's ad hoc subcommittee on consumer and environmental affairs, which he chairs.

"There's a patience level of [how much delay] we'll tolerate here, and it's about to run out," Dodd added, after announcing that the National Institute of Environmental Health Sciences had responded to his May request for a study by saying only that it might do a feasibility study (see *MWN*, M/A92).

Sen. John Glenn (D-OH), chairman of the committee, who also participated in the hearing, said that he is "extremely disturbed" about reported links between police radar use and cancer (see *MWN*, J/A91, S/O91 and M/A92).

After the hearing, Lieberman, Dodd, Glenn and Sen. Dennis DeConcini (D-AZ) asked the Senate Appropriations Committee subcommittee on labor, health and human services and education to fund the study. The subcommittee did not earmark funds for a study but added language to appropriations legislation for NIOSH urging the agency to conduct one. An aide to Sen. Tom Harkin (D-IA), who chairs the subcommittee, told

Microwave News that NIOSH "seems willing to move forward," but added that the legislation does not require the study. Funding would come from the agency's general operating budget, she said.

NIOSH's Dr. Bryan Hardin endorsed the study at the August hearing and said that "caution in the use of radar guns...is prudent" until more research is done. In materials sent to Lieberman in late August, NIOSH estimated that the study would cost \$1.7 million and take three to five years.

Lieberman has asked the Environmental Protection Agency

"Wow!"

At one point during the hearing, Sen. Lieberman asked Dr. Ross Adey what other technologies might pose health risks if police radar is indeed a cancer threat.

Adey listed electric blankets, microwave ovens, radio-frequency sealers and cellular phones, which he said can produce "a quite high field in the brain."

"Wow! There's a lot to be worried about here," Lieberman said, acknowledging a moment later that his response was "non-senatorial."

Adey's point was reinforced by a letter Lieberman received following the hearing from Dr. Eleanor Adair of the John Pierce Laboratory in New Haven, CT, who is skeptical of police radar hazards. She wrote: "If you accept the indictment that radar guns produce cancer, then you must so indict every similar device."

(EPA) to transfer to NIOSH some of the \$1.8 million in unspent funds that EPA received last year for electromagnetic field (EMF) research (see *MWN*, J/A92). On August 13, Lieberman wrote to EPA Administrator William Reilly urging the agency to transfer the money "so that NIOSH can initiate this needed study at the earliest possible time." In a September 21 response, EPA's assistant administrator for R&D, Dr. Erich Bretthauer, declined, for the present, to release any funds.

The study was backed by John Kusek, a vice president of Kustom Signals Inc., one of the nation's largest manufacturers of police radar devices, though he maintained that police radar is not hazardous. In his testimony, Kusek explained that, "We feel research would substantiate our view of the risk." He defended the safety of Kustom's radar units on the basis of the 1991 Institute of Electrical and Electronics Engineers (IEEE) exposure guidelines, which he said were designed to be "as conservative as possible" (see *MWN*, N/D91).

Kusek also disclosed that his company has sued Connecticut to block the ban on hand-held radar units that the state enacted earlier this year (see below). About 30% of all police radar units are hand-held, he estimated.

Dr. Ross Adey of the Veterans Administration Hospital in Loma Linda, CA testified that low-power radar sources could be harmful. Citing recent findings by Germany's Drs. Werner Grundler and Friedemann Kaiser, Adey suggested that it may not be possible to define a threshold below which radar emissions are safe. "Clear responses occurred at incident field levels of 5 picowatts/cm², about one million times below field levels

permitted" under the IEEE guideline, Adey said, concluding that the standard, which permits exposures to 5 mW/cm² at police radar frequencies, is too lenient.

Asked by Lieberman whether police officers have "a legitimate cause to worry," Adey responded that police radar "may carry a significant biological and biomedical risk based on both the physical evidence and the biological evidence."

Henry Kues of the Johns Hopkins University Applied Physics Lab (JHU-APL) in Laurel, MD described his research on the effects of microwaves on the eye (see *MWN*, S/O91). He noted that, under certain circumstances, police officers using hand-held radar are exposed to levels higher than those allowed under the 100 μ W/cm² JHU-APL exposure standard (see *MWN*, D84).

John Rankine, a member of the IEEE's standards board, said he doubts police radar is harmful. But he added that he views anecdotal reports of an association between police radar and cancer "with concern" and supports a study. Rankine said the 1991 IEEE standard was written by "the most open, best attended and best qualified committee" among the hundreds that have developed IEEE standards.

Police officers testifying at the hearing urged Lieberman and Dodd to make sure the federal study gets done. "Senators, you are our last best hope," Ohio State Trooper Gary Poynter testified. Poynter's compilation of cancer incidence among police officers first brought the police radar issue to national attention. He noted that the total number of cancer cases he has cataloged is now 168, up from the 89 cases he had identified as of last spring (see *MWN*, M/A91 and M/A92).

Windsor Locks, CT policeman Thomas Malcolm, whose testicular cancer is in remission, showed the senators at the hearing how he had rested the radar unit near his groin without turning it off (see *MWN*, S/O91). He also urged Lieberman and Dodd to act. "If I can save one more police officer, then I've done my job. If you can force a study, then you've done your job," he said.

Sam Franzo, representing the International Brotherhood of Police Officers in Rocky Hill, CT, said that his union supports a national ban on the use of police radar transmitters inside cars. "We just want the antenna outside the car and a national study. What's the big deal?" he asked.

Radar Manufacturer Sues Connecticut

Kustom Signals Inc. of Lenexa, KS has filed suit against Connecticut Governor Lowell Weicker and other state officials, challenging the state's ban on hand-held radar. In its August 7 complaint, Kustom said that the law violates the company's constitutional rights and was passed "without credible scientific support."

Connecticut enacted the law on June 1 to "protect police officers from the risk of cancer caused by the use of hand-held radar devices," according to Sen. Joseph Lieberman (see *MWN*, M/A92 and M/J92). The senator told *Microwave News* that he is confident the ban will be upheld, adding that it is a "moderate, reasonable response" to the threat police officers face when they use hand-held radar.

Kustom Signals, a leading manufacturer of traffic radar, argued in its claim that "non-ionizing emissions from hand-held radar devices are very low, and exposure even at the closest possible distance to them does not constitute a hazard to human health....It is not reasonable to conclude from the existing data that radiofrequency exposure from hand-held radar devices is a cause of cancer."

The defendants in the suit have not yet been served. Kustom has 120 days from the time the claim was filed in U.S. District Court in Hartford to notify Weicker and others formally about the complaint; otherwise, it could be dismissed. William Ruppert, chairman and CEO of Kustom Signals, did not respond to repeated telephone calls from *Microwave News*.

VDT Foundation Establishes Health Research Center at JHU

The Johns Hopkins University (JHU) School of Hygiene and Public Health in Baltimore has been selected to run the Center for VDT and Health Research on behalf of the VDT Health Research Foundation (HRF). Dr. Ronald Gray, a physician and epidemiologist with a background in reproductive health issues, was named director, and Dr. Patrick Breyse, a well-known EMF researcher, was named associate director.

Gray told *Microwave News* that a high priority will be an examination of what parameters of video display terminal (VDT) EMFs are important for studies of human health. The

center may host a workshop on this topic next year. Gray noted, however, that it is too early to say precisely what mix of studies the center will pursue.

An advisory board with ten to twelve members will select the center's projects, he explained. The board should be complete soon and will hold its first meeting later this year or early next year. It will include "some outstanding people" on exposure assessment, as well as experts on epidemiology, ergonomics and stress, Gray said.

The JHU School of Hygiene and Public Health has, in the past, been involved in research on cancer and occupational exposure to EMFs. Breyse has worked with Dr. Genevieve Matanoski on a major study of cancer among telephone workers (see *MWN*, N/D89 and J/A91). JHU researchers will be allowed to compete for funding from the center, Breyse said.

Launched last winter by IBM Corp., Apple Computer Inc. and Compaq Computer Corp. (see *MWN*, M/A92), the VDT

HRF has so far failed to enlist support from other corporations to expand its research funding base—a goal of the organization. Some computer makers may be apprehensive about pointing to a problem, said Philip Shellhaas, director of public policy programs for IBM and executive director of the foundation. In an interview at the *Work With Display Units '92* conference in Berlin in early September, Shellhaas said there may also be a concern "that any research that is sponsored by industry would be seen as less credible than work done by a government agency like NIOSH." He said that the foundation is presently talking to a "short list" of six or eight interested companies, and that he hopes to attract international support.

To date, the foundation has committed to providing the research center with about \$2.25 million over three years.

Columbia University, Harvard University, the University of California and the University of Texas had also been considered for the center.

FROM THE FIELD

BPA Updates EMF Guidelines

Following the recommendations of its EMF task force, the Bonneville Power Administration (BPA) has updated its EMF guidelines, last revised in 1988. "Where EMF[s] had been one of the many considerations in design and location of new BPA facilities, [they are] now a major decision factor," according to a memo that accompanied the new guidelines. The full text of the 1992 Bonneville Interim Guidelines on Electric and Magnetic Fields, which went into effect in June, appears below. For more information, contact: Dr. Jack Lee, Bonneville Power Administration, PO Box 3621 (EFB), Portland, OR 97208, (503) 230-4530.

Recognizing

- that public concern is increasing over potential health effects of EMFs and that this concern is important to BPA,
- that a clear course of action cannot be determined from present scientific evidence and
- that defining and addressing any risks associated with EMFs is the responsibility of the entire society, which values both the availability of energy and the well-being of its citizens,

BPA adopts the following revised interim guidelines governing its practices with regard to electric and magnetic fields. As new information becomes available, these guidelines will be reexamined. Such reexamination will occur at least every two years.

1. Because it appears that it will take several more years before sufficient scientific data is available to establish whether EMFs are a threat to public or worker health, it does not appear prudent at this time for BPA to modify existing electrical field standards or establish numerical field strength standards for magnetic fields produced by BPA facilities.

As states in the region review the issue of EMFs and consider limits on these fields, BPA will participate in the process. BPA will adopt practices consistent with EMF standards in such states, to the maximum extent practicable.

2. BPA will continue to support R&D efforts dealing with EMF issues.

3. In arriving at design and location choices for new transmission facilities:

- EMF exposure shall be a major decision factor to be balanced with other major decision factors (such as reliability).

- Accordingly, BPA shall seek to keep EMF exposures as low as are reasonably achievable, considering social, economic and environmental factors.

- BPA will consider both existing mitigation techniques (such as developing alternative facility locations; increasing right-of-way widths; altering line or tower geometry; using higher voltages to reduce current levels; and undergrounding) and developing technology. The practicability of these options will be determined on a case-by-case basis.

4. Where practical alternatives exist, public and employee exposure to EMFs should not be increased by any BPA operations, practices or actions.

5. BPA employees will be kept informed on current research and information.

6. BPA will explore, in conjunction with its employees, ways to reduce exposures in carrying out their jobs.

7. BPA will actively seek to inform and involve affected customers and the public in BPA project development, including evaluation of siting factors such as EMFs. BPA will continue to develop appropriate educational materials and to respond to requests from the public for information or measurement of EMFs associated with the BPA transmission system.

8. BPA will involve its utility customers and the public in its policy deliberations on EMFs.

Radar and Nerve Damage: A WWII Veteran's Case Report

To the Editor:

During World War II, I served in the U.S. Navy as an aviation radar specialist assigned to an airborne antisubmarine branch of the Atlantic Fleet.

For three years, I worked on S-band (2-4 GHz) airborne search radar units that were rated at 50 kW peak power (36 W average power). In a small shop set up for the purpose, I serviced and tested these radars,

FROM THE FIELD

often using something known as an echo box—a cylindrical cavity that simulated echoes when placed in the radar beam. The echo box required tuning adjustments during this procedure, forcing me to work directly in front of the radiating antenna.

During training I was never told of any microwave exposure hazards, and in fact I was taught this specific maintenance procedure, which required extensive, direct exposure to microwaves. I would commonly spend an hour or two at a time in the beam of the radiating antenna.

Generally, the right side of my head was nearest the radar antenna—just four feet away. At this distance, the radar had a free-space field intensity of about 32 mW/cm². But I believe that numerous field reflections were present to cause even higher exposures. Possibly most important, the radar signals were intensified by a two-inch metal denture I wore on the right side of my mouth—with the result that the adjacent facial nerve tissue was thermally injured.

My nerve injury occurred suddenly in late 1944. After servicing a radar with the echo box procedure, a swelling developed under my right maxillary bone prominence, just above the location of the denture. Soon I found that my face was insensitive to touch around the swelling. I assumed it was an insect bite. After a week or two, the swelling receded but a sense of facial numbness on the right side remained and has persisted to this day.

I began to drool saliva uncontrollably and dribble food out of the right side of my mouth. Feeling at the time that this was a temporary but personal ailment that should be hidden from my peers and my superiors to avoid ridicule and possible discrimination in advancement, I developed ways to hide my injury from others.

When I was discharged from the Navy in 1946, my wife saw my condition and insisted that I consult with the family doctor, who promptly directed me to a neurologist. The neurologist performed extensive nerve tests, X-ray studies and a spinal tap, and he had tissue removed from the right maxillary sinus for examination. He concluded that the fifth, seventh, and, to a lesser degree, third nerves were damaged and said he believed that demyelination had occurred. This doctor found no evidence of a tumor or disease, but he remarked that the onset of the condition and other symptoms reminded him of an X-

ray or diathermy exposure injury.

I related the story of my radar exposure but the doctor expressed total ignorance of microwave effects on humans. I dropped the matter though the symptoms remained and, I believe, presented handicaps in my relationships with employers and social contacts.

I developed eye problems that can be connected to my radar exposure as well: bilateral cataracts and retinal detachments. My right eye conjunctiva had no feeling (as a result of the damage to the fifth nerve), and this eye had retinal lesions, seriously restricting the sharpness of my vision and my field of view.

In 1976, 32 years after my microwave exposures, I read a news article by Jack Anderson revealing to the public for the first time evidence of injuries to World War II veterans who worked on radar. Noting similarities with my own neural and visual disorders, I sought and obtained new neurological and eye examinations. This time, the doctors concluded that the wartime exposures were the logical cause. The neural disorder was believed to be the result of a thermal lesion produced by focused microwave radiation in the vicinity of the metal denture that I wore.

I then prepared and presented claims to the Veterans Administration (VA) for both the eye and nerve injuries. After several denials and subsequent appeals over a period of 14 years, the VA agreed to my claim for eye injuries, but flatly disagreed that the neuropathy had anything to do with microwaves. VA officials argued that it was impossible to prove that my exposure could have been "excessive," and they claimed that there is no scientifically or medically recognized link between exposure to microwave radiation and peripheral (facial area) cranial nerve damage.

I am now 75 years of age, and I still live with my neural disorder and still believe that it resulted from being exposed to radar microwaves. I hope to prove it somehow, if only to benefit a fuller scientific and medical understanding of injuries such as mine.

Sincerely,
John McWade
67690 Ontina Rd.
Cathedral City, CA 92234

UPDATES

BROADCAST TOWERS

Expansion Limits...Health concerns are keeping the debate over radio and television towers alive in Seattle. In August, the city enacted a height limit that is designed, according to City Councilwoman Sue Donaldson, to keep new "super towers" from being built and to provide an incentive for broadcasters to move their facilities to nonresidential areas. The ordinance sets an overall height limit of 1,100 feet above sea level, which is about 100 feet higher than the tallest existing towers, and specifies other restrictions on expansion. Donaldson, chair of the city's land-use committee and the sponsor of the measure, told *Microwave News* that the cap would "keep a speculative, very tall tower from coming in." She was referring to a proposed 1,000-foot tower—rising 1,400 feet above sea level—that could have encouraged other broadcasters in the area to increase the height of their existing towers. Don Wilkinson, director of engineering for KOMO television, said that his station has had plans since the mid-1980s to raise its existing tower to 1,350 feet

above sea level. With this move now blocked, Wilkinson explained, the station may have difficulties in accommodating new broadcast technologies such as high-definition television. But Wilkinson argued that the new ordinance will not force the station to move its facility to a less-populated location outside the city, stating that the towers for all local TV stations "need to be centrally located and reasonably close together." The ordinance is a compromise "that we're not terribly pleased with," Wilkinson said. The most vehement opponents of Seattle's broadcast towers were also dissatisfied with the new rules, according to Steve Ludwig, president of Citizens Against Tower Expansion (CATE). Members of his organization, who are concerned about reports of elevated cancer rates in their Queen Anne Hill neighborhood, were part of an angry, noisy crowd of protesters that twice forced the city council to adjourn while it voted on the broadcast tower ordinance on August 10. Seattle adopted public exposure guidelines for RF radiation last January (see *MWN*, J/F92).

INTERNATIONAL

Radar and Power Line Fears in Ireland...In the small town of Crossmaglen, Northern Ireland, near the border with the Republic of Ireland, ten people have died from brain hemorrhages and three from brain tumors—out of a population of about 2,400—in the last two years, and residents suspect NIER from a nearby British Army surveillance post, according to an account in the *Dublin Sunday Press* (June 28). A local physician, Dr. Mary Allen, sounded the alarm. "In all the areas I have worked I have never experienced such a high level of general illness," Allen told the *Press*. "This ranges from listlessness and insomnia to cancer and mental illnesses, including anxiety and depression. We need a comprehensive survey of the health of the community...and we need the Army to disclose what type of equipment they're using." The newspaper reported that the British Army has "been using surface movement radar in the area since 1986."...EMFs from power lines are causing concern in the Dublin suburb of Ballymun. The June 8 *Evening Herald* reported that seven women in a 400-house development known as Belclare Estate have died of cancer in the last 14 months. An environmental group, Healthwatch Ireland, has taken EMF measurements, which are in turn being reviewed by a government agency, and the Irish Minister for Health, Dr. John O'Connell, has begun an investigation into the Ballymun cancer cluster. "You cannot start a total scare, but these figures warrant further study...by a team of epidemiologists," Dr. Patricia Sheehan, a radiation researcher, told the *Herald*. "No one knows what causes cancer, but it has been established that when people are exposed to non-ionizing radiation and ionizing radiation there is an increase in cancer."

BBC Tower Sparks Controversy...An environmental health specialist in Birmingham, U.K., Dr. Mark Payne, has identified seven cases of leukemia and lymphoma among residents who live within 1,500 meters of a British Broadcasting Corp. (BBC) radio and television tower, according to reports on March 30 in *The Guardian* and in *The Birmingham Post*. All but one lived in the area for at least 14 years. The 750-foot tower transmits four television and seven radio stations. Payne culled the cancer cases from the medical records of a general practitioner in the area who has about 2,600 patients. He also found that there are 12 area residents currently receiving treatment for mental illness. "Had the Sutton Coldfield transmitter been a new drug, it would have to have passed elaborate tests as to its long-term safety," Payne wrote in an as-yet-unpublished letter to a British medical journal obtained by *Microwave News*. Such tests are not required, he added, "because of the widely held view that, apart from the heating effect, non-ionizing radiation presents no health hazards. We need to reassess this [view]."

MILITARY SYSTEMS

Microwave Weaponry...An article in *Aviation Week & Space Technology* flatly contradicts a report in a competing publication that an EMP weapon was used in the Gulf War. The earlier

story, in the April 13-19 issue of *Defense News*, stated that an EMP warhead mounted on the Navy's Tomahawk cruise missile was used in the opening days of Operation Desert Storm (see *MWN*, M/J92). The weapon, also referred to as a high-power microwave (HPM) device, was meant to disrupt electronics in Iraq's air defense systems, wrote coauthors Robert Holzer and Neil Munro. The piece in the April 27 *Aviation Week* confirmed part of the earlier report, quoting unnamed U.S. defense officials who said that a "Tomahawk-size" EMP warhead is being developed in projects at Los Alamos National Laboratory, NM and Eglin Air Force Base, FL. "[B]ut no such weapon was used against Iraq," *Aviation Week* reporter David Fulghum wrote. His story was not primarily about EMP weapons and made no specific reference to *Defense News*. Rather, the three-page article described a secret offensive to disrupt Iraqi air defenses. *Defense News'* Munro said his sources stick by their original story.

TECHNOLOGY

Microwave Dryers...For those who have toyed with the possibility of drying clothes in a microwave oven, just wait. American Micro-Tech Inc. of Lake Oswego, OR is developing a microwave clothes dryer. Tests of the appliance that were sponsored by Southern California Edison have shown a 10% energy savings as compared with a conventional electric dryer. The utility also touts faster drying, fewer wrinkles and less static cling. The dryer is a modified household tumble dryer: microwave generators have been added, along with door locks and shielding; a low-wattage electric heating unit is still needed to help carry moisture out of the dryer....EPRI researchers are also studying this technology and have recently completed a prototype. They are still working out some kinks, however: metal buttons, coins and zippers are not a problem in the microwave dryer, but long, thin metal objects such as bobby pins or nails can heat up and damage clothing. "In a microwave dryer...microwaves 'target' the water molecules clinging to the clothes rather than the molecules constituting the fabrics," EPRI's John Kesselring wrote in the June *EPRI Journal* (pp.34-36). "In experimental testing, dryer temperatures...generally have not exceeded 110°F, an excellent range for drying delicate fabrics," Kesselring, who is with EPRI's Customer Systems Division, predicted that the dryers could be on the market as early as 1994. Past announcements that this technology would soon be available to consumers have proved to be premature, however (see *MWN*, N/D88).

CORRECTION

In our last issue, we misstated the per-mile construction costs of overhead and underground power lines in the article on "The Economics of Mitigation" (p.4). The cost of a 345 kV H-frame configuration is \$390,000 per mile and the cost of burying the same line is \$1,450,000 per mile, according to a report prepared for Rhode Island's EMF task force by Commonwealth Associates.

might require that average annual exposures be less than 2 mG, noting that peak fields would be less than 4 mG. The average exposure could end up being 3 or 4 mG, Nöu said. "We will have to balance the health of the Swedish population with the economic costs of the standard." NUTEK is responsible for electrical safety regulations in Sweden.

If the 2 mG average limit is adopted, there will be a right-of-way (ROW) of approximately 200 meters—about 300 feet on each side—for a 400 kV power line, according to Nöu. He noted that this ROW could be reduced to 100 meters with low magnetic field transmission designs and the use of other mitigation strategies.

"The most difficult problem is what to do about existing homes and power lines," Nöu said. "The cost of decreasing these magnetic fields will be enormous."

Rolf Lindgren, the EMF manager for the state power company, Vattenfall, and a member of NUTEK's safety standards committee, told *Microwave News* that exposures above 2 mG from existing power lines and substations would be addressed "on a case-by-case basis," adding that, "Changes would have to be weighed against the economic costs."

When asked whether Sweden would adopt a 2 mG occupational standard, Lindgren replied that such a limit "would bring an end to industrial society in Sweden." He predicted that market forces, which will now favor low magnetic field systems, would yield ways of reducing worker and public exposures.

A 2-4 mG population standard would be up to 100 times more stringent than the standards adopted by New York State and Florida—the only two magnetic field limits in the U.S. (see *MWN*, M/A89 and S/O90). It would be up to 500 times stricter than the International Radiation Protection Association (IRPA) guidelines for public exposures to 50/60 Hz magnetic fields and up to 2,500 times stricter than IRPA's occupational standard (see *MWN*, M/J89).

The new epidemiological results are, in the words of NIOH's Dr. Kjell Hansson Mild, "remarkably clear in pointing to a connection between cancer and magnetic field exposures." And Dr. Lars-Erik Paulsson of the Swedish Radiation Protection Institute in Stockholm said that, "The childhood cancer study confirms earlier findings with astonishing precision." Both Mild, who is based in Umeå, and Paulsson were present when the epidemiological results and the NUTEK policy were announced in Stockholm.

Lindgren and Mild both cited the need to design new homes with electrical circuitry that would limit magnetic field exposures. Similarly, in an interview with *Microwave News*, Per Erik Boivie of the Swedish Confederation of Professional Employees, TCO, in Stockholm, argued for low magnetic fields in new office buildings. "We think our strategy to bring down fields as low as possible is a very good strategy," he said.

In its public statement, NUTEK made a commitment to sponsor more research to determine the mechanism of interaction—a move endorsed by many of the Swedish officials interviewed for this report.

The Ahlbom-Feychting and Floderus studies cost more

than \$2 million and took more than five years to complete (see *MWN*, M/J87). Both groups said that they will soon submit their results for publication. The epidemiological studies are part of a larger Swedish research program, which includes studies on animals and on cellular systems.

Reactions In the U.S. and the U.K.

Few American researchers have yet seen the full reports of the two studies, but summaries have been widely disseminated (see p. 14 for the full texts of the abstracts). "The results are very suggestive of a real association with childhood leukemia," said Dr. David Savitz, an epidemiologist at the University of North Carolina, Chapel Hill. Similarly, Dr. Richard Stevens of the Battelle Pacific Northwest Lab in Richland, WA said that, "It is hard to imagine what obvious problem could account for these results other than magnetic fields." With respect to the occupational study, Dr. Sam Milham, who recently retired from the Washington State Department of Health, said, "It's a confirmation that EMF exposures are associated with certain cancers."

"My first thought is that this further evidence, coming from extensive work by well-established scientists, may finally allow scientists who would like to work on the problem to do so without unwarranted put-downs by the 'old boys' of science," Dr. Nancy Wertheimer told *Microwave News* from her office in Boulder, CO. In 1979, Wertheimer, working with physicist Ed Leeper, first identified the link between childhood cancer and high current lines by using a system of wire codes to estimate long-term magnetic field exposures.

Representatives of utilities outside Sweden are reserving final judgment on the new research until they have had a chance to analyze the studies carefully.

The Ahlbom-Feychting study was "rigorously conducted" and "provides important new information," according to the Electric Power Research Institute (EPRI) in Palo Alto, CA. In an interview, Dr. Stanley Sussman, manager of EMF health studies, said, "We're trying to put it into perspective with the rest of the literature. Frankly, we need more information, particularly with respect to the modeling of the historical fields, which is critical to their results." Sussman said that EPRI had not yet completed its review of the Floderus occupational study.

Robert Beck, vice president for environmental affairs at the Edison Electric Institute (EEI) in Washington, called the studies "important contributions to our body of knowledge," adding

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that they "provide us with some more answers, and questions, to the EMF puzzle." He stressed "the need for a coordinated and comprehensive national research program into possible EMF health effects." (Congress has now passed such a plan, see p.2.)

Richard Loughery, EEI's EMF issue manager, said that he looks forward to debating the new results at the Department of Energy's (DOE) annual review of EMF research, which will be held in San Diego on November 9-12. Both Ahlbom and Floerus will present their results at the DOE meeting.

In the U.K., Dr. John Male of the National Grid Co. in Leatherhead, Surrey told *Microwave News* that, "We see this as an important addition to the scientific data base. We await an assessment of its significance by the National Radiological Protection Board (NRPB)." Last spring, the board issued a report which concluded that there is "no firm evidence" of a cancer risk from exposures to power frequency EMFs (see *MWN*, M/A92).

Ahlbom-Feychting Residential Study

Ahlbom and Feychting used the most detailed exposure assessment ever attempted, reconstructing long-term magnetic field exposures for those living next to high voltage power lines. First, they used a computer model to calculate the magnetic fields inside homes next to power lines carrying a known amount of current and confirmed the accuracy of the model with spot measurements. Then, using Vattenfall's historical records of the current loads on the nation's power lines, they estimated the average field exposures for each case and for corresponding controls at the year of diagnosis as well as one, five and ten years before diagnosis; they also estimated exposures for children at the time of birth and at the time of conception.

Based on these estimated long-term exposures, Ahlbom and Feychting found that childhood leukemia rates rose with increasing magnetic field exposures—a clear dose-response relationship. Children exposed to more than 1 mG had twice, those exposed to more than 2 mG had close to three times, and those exposed to more than 3 mG had nearly four times the incidence of leukemia of those exposed to less than 1 mG. Despite a small number of cases, the risk ratios are statistically significant. The researchers found similar results when exposure was defined by proximity to power lines.

Ahlbom and Feychting noted that controlling "for confounding from air pollution or socioeconomic status did not change the results."

In the U.S., Savitz and Dr. John Peters of the University of Southern California (USC) have each shown that children living near high current power lines have higher rates of cancer, but neither found a significant association with measured magnetic fields (see *MWN*, N/D86 and M/A91). Savitz and Peters each confirmed the landmark Wertheimer-Leeper study.

Importantly, like Savitz and Peters, Ahlbom and Feychting did not find a link between childhood cancer and spot magnetic field measurements. In a telephone interview, Feychting explained that, because currents on power lines have increased over the years, spot measurements do not correlate with the historical estimates—and tend to overestimate past exposures.

Norwegian and Danish Studies Also Point to Cancer Risk

Two other Scandinavian epidemiological studies—one on Norwegian workers and one on Danish children—also point to an EMF-cancer risk.

Drs. Tore Tynes, Aage Andersen and Frøydis Langmark of the Cancer Registry of Norway in Oslo report that male electrical workers with a "long duration of employment" had a statistically significant 40% increase in acute and chronic leukemia. The highest risks were among radio and TV repairmen, radio and telegraph operators and power line workers.

The results, which were based on an investigation of approximately 38,000 workers, appear in the July 1 issue of the *American Journal of Epidemiology* (136, pp.81-88, 1992). The researchers did not see an increased risk of brain tumors. Tynes and Andersen previously reported that this group of workers had an abnormally high rate of breast cancer (see *MWN*, J/F91).

And on October 7, as we went to press, Dr. Jørgen Olsen of the Danish Cancer Registry in Copenhagen announced that children living near high voltage power lines with magnetic field exposures of 1 mG or more had a statistically significant fivefold elevated risk of lymphoma, as compared with controls. Although no excess risk of leukemia or brain tumors was observed, the combined risk for these three types of childhood cancer was more than five-and-a-half times greater for exposures of 4 mG or more, as compared with controls.

"It is not possible to use spot measurements to know historical exposures," she said. "Our study provides a possible explanation as to why Savitz and the USC researchers found associations with wire codes and not with spot measurements," she concluded.

Savitz pointed out that the new study "has its own methodological strengths and weaknesses and these are different from the U.S. studies—it's not another Wertheimer-Leeper or Peters study." Battelle's Stevens noted that questions about control selection that have been raised with regard to the American studies—for instance, potential biases due to random digit dialing—do not apply to the Ahlbom-Feychting study.

For adults, Ahlbom and Feychting found a 70% excess of both acute myeloid leukemia (AML) and chronic myeloid leukemia (CML) for those exposed to more than 2 mG, as compared to those exposed to less than 1 mG. Neither of these results is statistically significant, however.

Unlike Wertheimer and Savitz, or Sweden's Dr. Lennart Tommenius (see *MWN*, N82, M/J86 and N/D87), Ahlbom and Feychting did not identify an EMF link to brain tumors in children. (Peters only looked at leukemia.) Nor did they find a link to brain tumors among adults. "We were surprised that we did not see a risk for brain tumors," Feychting said. Savitz

commented that, "Up until this study, the evidence was stronger for brain cancer than for leukemia. This shifts the balance somewhat."

The elevated cancer risk appears to apply only to those children who lived in single-family homes. In their report, Ahlbom and Feychting argued that this lack of an association may be explained by the small number of cases and because the "precision of the calculated fields may be lower for apartment houses than for one-family homes."

Ahlbom and Feychting's case-control study included all

children with cancer and all adults with leukemia or brain tumors diagnosed between 1960 and 1985, among the nearly 500,000 people who lived within 300 meters of any of Sweden's 15,000 km of 220 and 400 kV lines. The researchers identified 142 children with cancer—39 with leukemia and 33 with brain tumors—and 558 controls. Among the adults, 325 cases of leukemia and 223 cases of brain tumors were compared with 1,091 controls.

"It would be very difficult to do this kind of study in the U.S.," Savitz pointed out, citing the detailed population, cancer

Abstracts of the Swedish Epidemiological Studies

On September 30, Maria Feychting and Anders Ahlbom of the Institute of Environmental Medicine at the Karolinska Institute, Stockholm, released their study, Magnetic Fields and Cancer in People Residing Near Swedish High Voltage Power Lines. On the same day, Dr. Birgitta Floderus and coworkers at the Department of Neuromedicine at the National Institute of Occupational Health in Solna released Occupational Exposure to Electromagnetic Fields in Relation to Leukemia and Brain Tumors: A Case-Control Study. Reprinted below are the authors' summaries of the studies.

Ahlbom-Feychting Residential Study

The aim of the present study was to test the hypothesis that exposure to magnetic fields of the type generated by high voltage power lines increases cancer incidence. The study was designed as a case-control study based on the population comprised of everyone who lived on property located within 300 meters from any of the 220 and 400 kV power lines in Sweden during the period from 1960 through 1985. For adults it was required that the duration of residence was at least one year. The corridor was chosen to be wide enough to ensure that it included both exposed and unexposed homes. The cases were all instances of cancer diagnosed between 1960-85. For children, all types of cancer were included, while for adults the study was restricted to leukemia and brain tumors. The cases were identified through a record linkage to the Cancer Registry. The controls were matched to the cases on time of diagnosis, age, sex, parish and power line. Exposure was assessed in several different ways. First, spot measurements were performed in the homes of the subjects. Second, the magnetic fields generated by the power lines were calculated by means of a computer program taking distance, line configuration and load into account. At the same time as a spot measurement was performed, the load on the line was obtained and the magnetic field calculated. Historical loads were obtained from records that were kept by the station managers. By using these in the program, calculated historical fields were obtained for various time periods appropriate from the etiological point of view. These calculated historical fields were the main source for classifying study subjects into different levels of magnetic field exposure. Thus, the main exposure metric was the annual average of the calculated magnetic field generated by the line. Third, for a sample of the subjects, 24-hour measurements were also performed.

For childhood leukemia and with cutoff points at 0.1 and 0.2 μT , the relative risk (RR) increased over the two exposure levels and was estimated at 2.7 (95% c.i.: 1.0-6.3) for 0.2 μT and over. The test for trend gave a p-value of 0.02. When the upper cutoff point was shifted to 0.3 μT the RR was instead 3.8 (1.4-9.3) and the corresponding trend test gave a p-value of 0.005. These results persisted when data were broken down by gender, age, time of diagnosis and area of living. However, it appeared that the relationship was confined to one-family homes. There was some relationship with distance but no relationship with spot measurements. Control for confounding from air pollution or socioeconomic status did not change the results. For brain tumors or for all

childhood cancers together there was little support for an association.

In adults and for magnetic fields of 0.2 μT and over, the RRs for acute myeloid leukemia (AML) and chronic myeloid leukemia (CML) were estimated at 1.7 (0.8-3.5) and 1.7 (0.7-3.8), respectively. This result persisted in most analyses. For brain tumors no association was seen.

The finding of an association, in childhood leukemia, with calculated historical fields but not with measurements is consistent with the assumption that historical calculated fields are reasonably good predictors of past fields but that spot measurements are poor predictors of those fields. The confinement of an association to one-family homes might be explained by a limited accuracy in exposure assessments in apartment houses. The results provide support for the hypothesis that exposure to magnetic fields increases the risk of cancer. This is most evident in childhood leukemia. What aspect of the fields might be involved remains unclear.

Floderus Occupational Study

The relationships between occupational EMF exposure and leukemia or brain tumors were analyzed in a case-control study. The exposure assessment was based on measurements, the cancer diagnoses were verified from medical records and the cases and the controls were representative samples of the general male population.

Based on the job held longest during the 10-year period before diagnosis, an association between leukemia risk and EMF exposure was observed. The association was attributed to chronic lymphocytic leukemia (CLL) and in particular to exposure based on EMF mean values; the relative risk increased with increasing level of exposure. No association was found for AML. Ever having had a high-exposure job during lifetime was more common among patients of CLL compared with control subjects. No such relationship was found for AML. It is unlikely that the results for leukemia are explained by confounding from benzene, ionizing radiation, pesticides, solvents or smoking habits.

For brain tumors, some results speak in favor of an association. The relative risk of brain tumors was increased in the highest exposure categories, based on median values for the job held longest during the decade before diagnosis. The occurrence of benzene, ionizing radiation, pesticides, solvents or smoking did not have any decisive influence on the results. The association found was mainly attributed to subjects below the age of 40, with no major difference between the two groups of brain tumors (astrocytoma grade I-II and III-IV). Ever having had a high-exposure job was more common among brain tumor cases than among control subjects in the youngest age group.

The complex relationships between age at first exposure, cumulative exposure and age at diagnosis have to be further explored, as well as the possible interactions of EMF with other factors. Also the inconsistencies between sub-diagnoses have to be evaluated. The results of this study speak in favor of the hypothesis that occupational EMF exposure is a hazard in the development of certain cancers.

and real estate registries, together with the long-term current load data, available in Sweden. "They used a very clever study design," he said.

Floderus Occupational Study

Floderus's occupational study also found a dose-response association between EMF exposures and cancer risk.

Floderus and coworkers, including Dr. Bengt Knave, divided the workers into four groups based on the intensity of their mean daily exposures to magnetic fields. The workers in the lowest quartile were exposed, on average, to less than 1.6 mG and in the highest quartile to 2.9 mG or more. A fifth group, the 10% of the workers who were most exposed, was used to evaluate further a possible dose-response relationship; this group was exposed, on average, to 4.1 mG or more. The bottom quartile served as the control group.

Workers in the top quartile had 60% more leukemia and three times as much CLL as those in the bottom quartile. The risk of CLL among the 10% most highly exposed workers was approximately four times that of the controls. All these results are statistically significant.

Interestingly, Floderus did not see elevated rates of AML among her male subjects. Many of the U.S. studies have identified an EMF link to AML rather than to CLL. "The CLL finding is very curious," Milham said, "but it's not the first time that it has turned up." Milham pointed to the studies by Dr. Michel Coleman in the U.K. (see *MWN*, Jun83), Dr. Neil Pearce in New Zealand (see *MWN*, J/A89) and Drs. Siv Törnqvist, Knave and Ahlbom in Sweden (see *MWN*, N/D91).

Floderus and coworkers noted that, "It is unlikely that the results for leukemia are explained by confounding from benzene, ionizing radiation, pesticides, solvents or smoking habits."

They also found a link between EMF exposures and brain tumors. In a telephone interview, Floderus told *Microwave News* that there was a stronger association with leukemia than with brain tumors and that the dose-response relationship was "more obvious" for leukemia.

"This is the first time that a dose-response relationship has been identified in an occupational study," Floderus said. "Of course, this makes the association more credible," she added.

The case-control study included 250 men with leukemia and 261 with brain tumors, and 1,121 controls. EMF exposures were measured with EMDEX meters. In their report, Floderus and coworkers wrote that, "In all, 1,015 [sets of] measurements were carried out on 169 job categories. The mean duration of measurements was 6.8 hours, which gave about 25 million record-

ings." Floderus declined to specify the occupations of the workers.

Milham was the first to identify a link between EMF exposures on the job and leukemia (see *MWN*, J/A82). Over the last ten years, occupational studies in Canada, Finland, France, New Zealand, Norway, Sweden, Switzerland, the U.K. and the U.S. have all pointed to an EMF-leukemia link (see *MWN*, D82, Jun83, My85, J/A85, M/A86, J/A86, M/J87, J/A89, S/O90, M/A91, J/A91 and p.13). In addition, a host of studies have indicated a link to brain tumors (see *MWN*, M/A90 for a review).

Is There a Nonexposed Population?

For both the occupational and residential studies, the differences in exposure levels between the exposed populations and controls were small. "These studies all understate the real risk because of background exposures," Milham said. "There is no such thing as nonexposed people. It's like comparing a three-pack-a-day smoker with a one- or two-pack-a-day smoker."

Wertheimer stressed the same point about the pervasiveness of EMF exposure. "We need to recognize that looking for a risk among people living near certain power lines is clouded by the many other sources of magnetic fields in modern society. As a result, one would expect results that are repeatedly positive but are relatively modest and variable in the risk levels observed."

The lack of a dose-response relationship between magnetic fields and cancer has long been cited by U.S. officials as a reason for doubting the EMF-cancer link (see *MWN*, M/J90).

In its review of the Environmental Protection Agency's (EPA) 1990 report on EMFs and cancer, EPA's Science Advisory Board argued that, "The conclusion of causality is currently inappropriate because of limited evidence of an exposure-response relationship and the lack of a clear understanding of biologic plausibility" (see *MWN*, J/A91).

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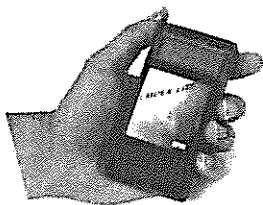
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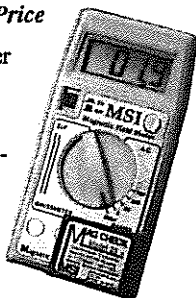
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