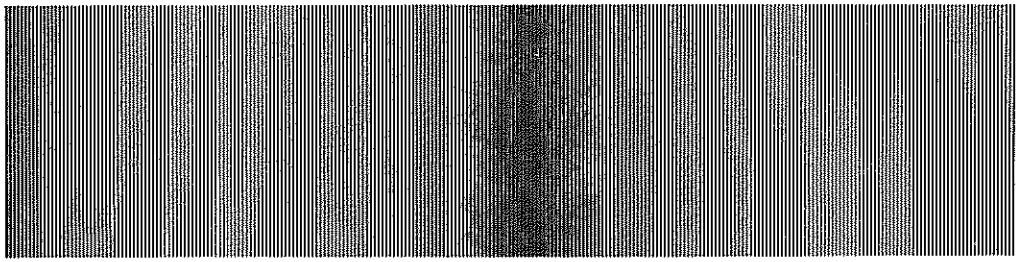


MICRO WAVE NEWS



Vol. VII No. 5

A Report on Non-Ionizing Radiation

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New RF/MW Exposure Standards: Sweden and Canada

The Swedish government has adopted – and the Canadian government has proposed – revisions in their radiofrequency and microwave (RF/MW) radiation exposure standards that will make them significantly stricter than before. They are the first regulations to take into account new data indicating that low frequency RF radiation is riskier than once believed (see *MWN*, July/August 1985).

On May 7, the Swedish National Board of Occupational Safety and Health (NBOSH) adopted new on-the-job limits – to take effect on January 1, 1988 – which are frequency-independent between 30 MHz and 300 GHz: 60 V/m and 0.16 A/m (1 mW/cm²) for the electric and magnetic fields, respectively.

In the 3-30 MHz band, the limits are 140 V/m and 0.40 A/m (approximately 5 mW/cm²) for on-the-job exposures. When the workers are in contact with electrical ground, the limits fall to 47 V/m and 0.13 A/m for 3-30 MHz and to 20 V/m and 0.05 A/m for 30-60 MHz (see table on p.5). There is no standard for exposures below 3 MHz.

Work is underway to revise standards governing the exposure of the
(continued on p.5)

Vision, Stealth & Mechanisms

Chemists at Carnegie-Mellon University have identified a family of compounds similar to rhodopsin – the molecule that is the basis of vision – which can absorb specific frequencies of radiofrequency and microwave (RF/MW) radiation. The potential implications and applications are enormous.

These compounds – retinyl Schiff base salts – promise to revolutionize the ability to make aircraft and other military hardware invisible to radar detection more efficiently than current “Stealth” technology, which is based on destructive interference by reflected signals. The findings may also help in deducing a mechanism for frequency-specific biological effects, especially those in the eye, where many different types of Schiff bases are naturally present.

After Dr. Robert Birge, the chairman of the chemistry department at Carnegie-Mellon University in Pittsburgh, PA, told *Aviation Week* that, “It should be possible to modify these salts so that an ensemble of them could absorb over the entire RF range,” the military moved in and put a cloak of secrecy over his work – it is now classified along with other Stealth research.

Thirty years ago, Drs. George Wald and Ruth Hubbard of Harvard University showed that a single photon could initiate a biochemical rearrangement in retinal, a Schiff base that is one of the components of
(continued on p.15)

HIGHLIGHTS

Ontario Hydro & IBM Study on PMFs and Reproductive Effects

Ontario Hydro and IBM are jointly sponsoring a study of the possible link between the pulsed magnetic fields (PMFs) associated with video display terminals (VDTs) and adverse pregnancy outcomes. "It will be a major experiment," according to Ontario Hydro's Murray Walsh, who is serving as the project manager.

The announcement of the new study follows reports from Sweden and Spain indicating reproductive effects among PMF-exposed mice and chick embryos (see *MWN*, March 1983, March/April and May/June 1986 and July/August 1987). An IBM spokesperson said that, while "extensive studies to date show no proof of hazard," questions about VDTs and pregnancy outcomes have been raised by the Swedish and Spanish research.

Dr. Michael Wiley, a professor of anatomy at the University of Toronto's Faculty of Medicine, will expose pregnant mice to simulated VDT fields for the first 18 days of pregnancy; the mice will then be killed and the embryos checked. Professor Paul Corey, a biostatistician at the university, will collaborate with Wiley.

The mice will be exposed to 20 kHz PMFs at three different intensities in an effort to see if there is a dose-response relationship, according to Ontario Hydro's Dr. Stuart Harvey, who is designing the exposure system. A fourth group of mice will serve as controls.

In a telephone interview, Walsh said that the experimental protocol is still in draft form but that current plans call for 200 mice in each of the four groups. The three exposure levels will be approximately 4, 16 and 200 μ T. Harvey told *Microwave News* that the levels are much greater than the average exposure of VDT operators, which he said is approximately 0.1 μ T.

A panel of experts from both sides of the Atlantic Ocean is being assembled to consult on the study. At press time, the names of the members of the panel had not been released.

A pilot study is scheduled to begin in October; the full-scale experiment will start in February, with results due in January 1989. The experiment will be run "blind"; Wiley will not know which are the exposed mice and which are the controls.

The project will cost \$400,000-500,000 (Canadian). Nei-

ther Ontario Hydro nor IBM would specify how much each company is contributing. IBM's role is limited to funding the study; the company will not be involved in its management.

The study is part of Ontario Hydro's project on the "Hazard Assessment of Video Display Units" (HAVDU): an animal exposure study was first announced nearly four years ago but was delayed until now (see *MWN*, January/February 1984). Walsh said that the delay was caused by "major budgetary restraints."

Suit Seeks More Protection Against HERO and ESD Risks

A lawsuit seeking greater protection against the accidental detonation of conventional and nuclear weapons by electromagnetic radiation (EMR), electrostatic discharge (ESD) and lightning was filed in federal court on September 1. The plaintiffs, a coalition of private citizens and activist groups, are asking the Department of Defense, each of the armed services and the Departments of Energy and Transportation to stop the use of electro-explosive devices (EEDs) until detailed environmental impact statements (EISs) on the siting of weapons with these devices near population centers have been completed.

In their complaint, the plaintiffs cite a number of incidents caused by EMR, ESD and lightning – they lump these together, calling them "hazards of EMR to ordnance," or "HERO." They warn of many possible accidents, including "the detonation of a nuclear or conventional weapon, the ejection of rockets or missiles, the firing of a rocket...the explosion of a weapon's fuel supply."

Patricia Axelrod, a ceramic tile designer from Key West, FL, is the moving force behind the petition, having spent the last two years researching HERO risks and accidents. Her concerns began when the Navy decided to reactivate an air station and to build a Homeport project, both in Key West, but failed to address potential HERO problems – for example, from nearby Coast Guard communications transmitters – in its EISs.

Asked about the allegations raised in the suit, Ramie Thompson of the Applied Physics Department at the Franklin Research Center in Philadelphia, PA, told *Microwave News* that there certainly are risks from HERO and ESD, but that, overall, the military "is not doing a bad job." Thompson is the editor of *Explosives and Pyrotechnics*, a newsletter published at the Franklin center.

Axelrod says that she is being investigated by the Naval Investigative Service because of her efforts to research HERO and related risks. In a background document, *The Deadly HERO*, Axelrod claims that more than 25 HERO accidents have occurred.

Axelrod has the backing of Dr. Theodore Taylor, a former nuclear weapons designer and staffer at the Defense Nuclear Agency, who has voiced his "deep concern" about accidental

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explosions.

The National Peace Academy of Abbeyhills in Columbus, OH, is also a plaintiff, as is its president, Thomas Siemer, a former Rockwell International Missile Systems Division manager, now retired.

The plaintiffs are represented by Edward Lee Rogers, an attorney based in Washington, DC, who was the principal deputy assistant secretary of the Army during the Carter Administration. Rogers also represents a group seeking detailed EISs on the military's electromagnetic pulse (EMP) simulators (see *MWN*, March/April 1987).

One of the best known accidents attributed to ESD was the

1985 fire at a Pershing II site in West Germany, which killed three servicemen and injured 16 others (see *MWN*, June 1985). This past June, three National Aeronautics and Space Administration (NASA) rockets were inadvertently launched from NASA's Wallops Island facility in Virginia after being struck by lightning (see also item on ESD contract on p.12).

NBS and FCC Step Up Action Against EMI

The National Bureau of Standards (NBS) and the Federal Communications Commission (FCC) are developing new ways of dealing with electromagnetic interference (EMI) problems.

EMC LAP Expands

The NBS has expanded its electromagnetic compatibility (EMC) National Voluntary Laboratory Accreditation Program (NVLAP) to meet the needs of the FCC and the U.S. Naval Air Systems Command. New test methods covering a host of FCC and military standards have been added to the ones established last year (see *MWN*, September/October 1986).

In a series of telephone interviews, members of the EMC community expressed their unanimous approval for the LAP and for the FCC's participation. "It's excellent," said Finbarr O'Connor of R&B Enterprises in West Conshohocken, PA. "It's a good sign for everybody; it adds credibility," concurred Ed Bronaugh of Electro-Metrics in Amsterdam, NY.

Uncertainty hangs over the program, however. A draft proposal is being circulated which would transfer laboratory accreditation to non-governmental organizations. The impetus for this comes from the American Association for Laboratory Accreditation.

If the informal proposal is well received, NBS will publish a proposed rule in the Federal Register for public comment. It would be at least a year before the LAP for any one industry is taken private, according to Harvey Berger, the manager of the NVLAP. Berger said that if the privatization proposal is approved, he doubts that the EMC LAP will be one of the first to be transferred out of NBS.

There are now 16 accredited labs: Spectrum Control, Inc., of Erie, PA, and Unisys Corp. of Salt Lake City, UT, have joined the 14 others that were on the original NBS roster. (GTE Evaluation & Support Dept. in Lexington, KY, has changed its name to Testmark Laboratories.) For more information on the EMC LAP, contact: Jeffrey Horlick, NVLAP, NBS, Admin A531, Gaithersburg, MD 20899, (301) 975-4016.

FCC Amends Measurement Methods

The FCC has amended its Procedure for Measuring RF Emissions from Computing Devices, better known as *MP-4*.

A Hazard for Surgeons?

Surgeons are often exposed to high levels of radio-frequency (RF) radiation while using electrosurgical units (ESUs), according to new measurements published in the July issue of the *Journal of Occupational Medicine*.

In a simulation of an operation, a team led by Dr. Jacob Paz of the New York Medical College in Valhalla found surgeons' eyes and foreheads were exposed to the highest levels of radiation – far in excess of the ANSI standard. The electric and magnetic fields were as high as 9,000,000 V²/m² and 3.5 A²/m², respectively. The ANSI standard is 4,000 V²/m² and 0.025 A²/m² between 30-300 MHz. Although not specified in the paper, ESUs operate at about 27 MHz in the ISM band.

An ESU is a standard fixture in most operating rooms; it is used to cut and seal tissue and to stop bleeding. In abdominal surgery, for instance, a surgeon may use an ESU in the coagulation or sealing mode 100 times or more in the course of one operation, according to Paz and coworkers. The team warns that "our result strongly suggests that a potential for eye injury exists" and calls for more research on exposure levels during surgery, as well as on the actual risks from extended exposure.

Paz also just completed taking measurements during an actual operation. The readings from a probe placed on the operating table were as high as 50,000,000 V²/m², with background levels between 1,000 and 3,000 V²/m². He did not take magnetic field measurements. Paz told *Microwave News* that these results, which have not been published, confirm his original work.

More than ten years ago, Dr. J.W.C. Fox and colleagues warned of the possible health risks due to RF radiation from ESUs in the operating room. Writing in *The Lancet* (i, p.962, May 1, 1976), they noted that they had measured power densities above 150 mW/cm² at the point of application and along the active lead of the unit.

HIGHLIGHTS

Although the changes are billed as "editorial," there are a number of substantive amendments. Among the changes are new ways to configure the cables during testing and a requirement that monitors display a repeating pattern of the letter "H" (scrolling H's) during testing.

The changes have met with differing reactions. Some of those involved in testing products agree that the changes are minor; others, like Glen Dash of Dash, Straus & Goodhue in Boxborough, MA, argue that the commission should have issued a formal proposal of its changes. Dash, who is both an engineer and an attorney, said that the changes go "way beyond" the threshold point for rulemaking.

The Computer and Business Equipment Manufacturers Association (CBEMA), which recently proposed some major changes to *MP-4* (see *MWN*, May/June 1987), warns that its members "could suffer severe economic impacts" from the changes and that some devices might have to be redesigned.

Dash said that the revisions in the *MP-4* document have "solved the debate on how the commission tests" but have not "solved the problem of repeatability." He called the scrolling H's a "mistake."

Art Wall of the FCC's testing lab in Columbia, MD, discounted the complaints, noting that it has been five years since *MP-4* was adopted and that it is time to incorporate the lessons learned.

On September 17, CBEMA asked the FCC to seek public comment on its "editorial" changes. Meanwhile, the FCC has extended the deadline for commenting on the revisions to *MP-4* proposed by CBEMA in April until November 15, with reply comments due on December 15.

Recent FCC test results indicate that certain electronics products are meeting the FCC's EMI rules. Tests of 16 VCRs showed that, with one minor exception, all passed the conducted and radiated emissions tests. Class B (for home use) computer devices did less well, with six of 15 failing the compliance requirements. The FCC's Wall said that the commission would recommend a simplification of the authorization requirement for VCRs – but not for Class B devices.

Copies of the revised *MP-4* are available from the FCC Consumer Assistance Office, 1919 M St., NW, Washington, DC 20554, (202) 632-7000. For more information on the FCC testing program, contact: Art Wall, FCC Lab., 7435 Oakland Mills Rd., Columbia, MD 21046, (301) 725-1585.

Conducted EMI Tests

The NBS and a consortium of collaborators are working to develop ways of protecting sensitive electronic equipment against power surges. Under the leadership of NBS's François Martzloff, a team is undertaking extensive measurements to better understand the propagation of pulses – from lightning, transformers and switches – through a building's electrical wiring.

Basic Measurement Instruments (BMI) is allowing the

NBS to inject surges into the power lines in its building in Foster City, CA. Martzloff said that BMI has already lost two laser printers as a result of the test surges. He explained that protecting against such losses can be complicated – in particular, he cited the problem of multiple grounds when many pieces of equipment are interconnected.

One of the project's main objectives is to recommend surge protection devices that are cost-effective. Martzloff notes – as others have in the past – that many commercially available surge protectors do not work and that, "It would be desirable for an objective organization to rate such devices." A staffer at Consumers Union in Mt. Vernon, NY, told *Microwave News* that it has no plans to test surge protectors at this time.

Members of the consortium include: BMI, Current Technology, Inc., EDCO, EPRI, GE, General Semiconductor Industries, Pass & Seymour and TII Industries, Inc. The Building Industry Consulting Service International, a trade group based in Tampa, FL, is the coordinator for the consortium.

Those interested in joining the effort or seeking more information, should contact: François Martzloff, B162 Metrology Bldg., NBS, Gaithersburg, MD 20899, (301) 975-2409.

EPA RF/MW Guidance Now Due in 1989

The Environmental Protection Agency (EPA) now expects to publish its guidance for public exposures to radiofrequency and microwave (RF/MW) radiation in July 1989.

EPA began working on the guidance in the 1970s, but its progress has been marked by repeated delays. In July 1986, EPA issued three options for limiting RF/MW exposures – the equivalent of 100, 200 and 1,000 $\mu\text{W}/\text{cm}^2$ – as well as a non-regulatory-action option (see *MWN*, July/August 1986). When the agency published its proposal last year, the schedule called for a final rule by the end of 1987.

In August, letters were sent to more than 20 federal agencies, asking them to designate representatives to the Interagency Working Group on Radiofrequency Radiation, which will be reactivated to monitor EPA's guidance development. The first meeting of the working group is scheduled for November. Once a federal radiation guidance is adopted by EPA and approved by the President, it must be implemented by federal agencies, not by EPA.

For more information, contact: Norbert Hankin, Office of Radiation Programs, ANR-461, EPA, 401 M St., SW, Washington, DC 20460, (202) 475-9630.

Swedish Occupational Exposure Limits

Frequency	E (V/m)	E _{grounded} (V/m)	E _{ceiling [grounded]} (V/m, rms)	H (A/m)	H _{grounded} (A/m)	H _{ceiling [grounded]} (A/m, rms)
3-30 MHz	140	47	300 [100]	0.40	0.13	0.8 [0.27]
30-60 MHz	60	20	300 [100]	0.16	0.05	0.8 [0.27]
60-300 MHz	60		300	0.16		0.8
0.3-300 GHz	60		300			

Time averaged over any six-minute period.
The ceiling values are averaged over one second.

Standards (continued from p.1)

general population, according to NBOSH's Dr. Kjell Hansson Mild.

Mild told *Microwave News* that a frequency-independent standard was adopted to simplify enforcement – so that health inspectors do not have to check the frequency of the emitter to know the applicable standard.

NBOSH has also specified a maximum exposure of 300 V/m and 0.8 A/m during any one-second period; normally, exposures are averaged over a six-minute interval. In the 3-60 MHz band, grounded workers cannot be exposed to more than 100 V/m or 0.27 A/m in any one second.

The new limits are the first revision since 1977, when the standard was set at 5 mW/cm² between 10 and 300 MHz and 1 mW/cm² between 300 MHz and 300 GHz.

For more information, contact: Dr. Kjell Hansson Mild, NBOSH, Box 6104, S-900 06 Umea, Sweden.

Following the lead of the U.S. National Council on Radiation Protection and Measurements (NCRP), the Canadian Bureau of Radiation and Medical Devices is planning to tighten allowable *public* exposures to RF/MW radiation by a factor of five. Like their Swedish counterparts, the Canadian rules are significantly more stringent when applied to grounded individuals or to those in contact with ungrounded objects.

For members of the general population, the Canadian proposal calls for an exposure limit of as low as 10 V/m, when people are grounded – for ungrounded individuals, the limit is 28 V/m (approximately 200 μW/cm²). In a telephone interview, Dr. Maria Stuchly of the radiation bureau said that the

Canadian General Population and Occupational Exposure Limits

Frequency	E _{occup} (V/m, rms)	E _{pop} (V/m, rms)	H _{occup} (A/m, rms)	H _{pop} (A/m, rms)
0.01-1.2 MHz	600	280	4	1.8
1.2-3 MHz	600	280	4.8 (f)	2.1 (f)
3-30 MHz	1800 (f) or 3120 (f ^{1.5})*	840 (f) or 1600 (f ^{1.5})*	4.8 (f)	2.1 (f)
30-100 MHz	60 or 20*	28 or 10*	0.16	0.07
100-300 MHz†	60 or 0.2 (f)*	28 or 0.1 (f)*	0.16	0.07
0.3-1.5 GHz	3.45 (f ^{0.5})	1.61 (f ^{0.5})	0.0093 (f ^{0.5})	0.004 (f ^{0.5})
1.5-300 GHz†	140	60	0.36	0.16

Pop = general population; Occup = occupational; f = frequency in MHz.

* The lower limits apply only when the exposed person is less than 0.1 m from electrical ground; in all other cases the higher limits apply.

† For 100-300 MHz, the power density is 1 mW/cm² for occupational exposure and 0.2 mW/cm² for general population exposure. For 1.5-300 GHz, the power density is 5 mW/cm² for occupational exposure and 1 mW/cm² for general population exposure.

HIGHLIGHTS

proposal "was motivated by the work of Drs. Om Gandhi and Bill Guy."

In a 67-page review and rationale for the revision of the 1979 Canadian standard, Stuchly argues for continuing to base occupational health standards on a specific absorption rate (SAR) of 4 W/Kg – or 0.4 W/Kg when a tenfold safety factor is applied – which was the basis of the 1982 American National Standards Institute (ANSI) guidelines. She rejects the U.S. Environmental Protection Agency's (EPA) 1 W/Kg threshold as being "based on a considerable number of assumptions, largely plausible but yet unproven."

Stuchly points out that the proposed standard builds in an added level of protection over the 0.4 W/Kg threshold with the lower exposure limits for grounded individuals.

For ungrounded workers, the limits are 60 V/m in the 30-300 MHz band, but 20 V/m for grounded workers exposed to 30-100 MHz radiation. For magnetic fields, the limit is 0.16 A/m for 30-300 MHz (see table for complete proposal).

In her rationale, Stuchly argues that, "Although pulsed fields are more effective in some cases than [continuous wave] fields in eliciting biological responses, the available scientific data are not sufficient for establishing thresholds for peak-field strengths."

Stuchly also calls the studies indicating that extremely low frequency-modulated RF fields can affect the movement of calcium "very important," "perplexing" and "the major unresolved issue," but has decided that these data "cannot be effectively used in standard setting at this time."

The new Canadian limits have been extended down to 10 kHz to address emissions from induction heaters, according to Stuchly (see *MWN*, March 1985).

The *Proposed Revision of the Canadian Recommendations on Radiofrequency Exposure Protection* will be published in the December issue of *Health Physics*. For more information, contact: Dr. Maria Stuchly, Bureau of Radiation and Medical Devices, Health and Welfare Canada, Room 233, Environmental Health Centre, Tunney's Pasture, Ottawa, Ontario K1A 0L2, Canada.

Portland, Oregon, Adopts 200 μ W Standard

After eight years of proposals, hearings and counter-proposals, the city of Portland, OR, has adopted its own radiofrequency and microwave (RF/MW) radiation exposure standard. "It's finally over," Steven Gerber of the city's Bureau of Planning told *Microwave News*. Gerber had shepherded the rules through the approval process since 1979. The standard took effect on September 18.

On August 19, the Portland City Council voted to accept limits that are five times stricter than those of the American National Standards Institute (ANSI) – 200 μ W/cm² between 30 and 300 MHz. The new Portland standard is identical to those already adopted by Multnomah County (in which Portland is located) and by the state of Massachusetts – and endorsed by the National Council on Radiation Protection and Measurements (NCRP).

Before the City Council's final vote, an earlier proposal to adopt a 100 μ W/cm² standard was reintroduced, but, according to Gerber, was again rejected. For the last three years, the city has had a moratorium on all new broadcasting transmitters of 500 watts or greater; the ban is now over.

Under the new rules, all existing radio and television broadcasters must register with the city, and applicants for new facilities must submit a radiation measurement survey. Low-power devices are generally exempted from regulation, as are amateur radio facilities and civilian and military radars.

For more information, contact: Steven Gerber, Bureau of Planning, 1120 S.W. Fifth Ave., Portland, OR 97204, (503) 796-7700. See also *MWN*, January/February 1982, July/August and November/December 1985 and March/April 1987.

ELF NEWS

EMFs and Brain Tumors: Link Questioned

A team from the National Cancer Institute (NCI) has found that male workers in electrical occupations have an increased risk of brain cancer, but the lead researcher, Dr. Terry Thomas, is "not convinced" that electromagnetic fields (EMFs) are responsible.

In a telephone interview, Thomas, who is now with the Veterans Administration's Department of Medicine and Surgery in Washington, DC, said, "I could not rule out [EMFs], but I don't think they are the likely cause for the excess in brain tumors." She cited the lack of "biological plausibility" as one reason for her skepticism.

In their paper, Thomas and coworkers cite other exposures common in electrical and electronics occupations, including soldering fumes, lead, solvents and other chemicals, which could play a role in causing the excess in brain tumors. (The paper refers to microwave and radiofrequency (MW/RF) radiation; Thomas said that this is a surrogate for all types of EMFs.)

The NCI team found that all electricians and electronics workers had an elevated risk of brain tumors; the relative risk (the ratio of the number of observed cases to controls) increased with length of employment, reaching a statistically

significant level of 10.4 for those with 20 or more years on the job.

Another study published earlier this year failed to find any elevated risk of brain tumors among Swedish electricians, power line workers or telecommunications workers.

The link between EMFs and brain tumors was first uncovered by Drs. Ruey Lin and Sam Milham.

See: Terry Thomas, et al., "Brain Tumor Mortality Risk Among Men with Electrical and Electronics Jobs: A Case-Control Study," *Journal of the National Cancer Institute (JNCI)*, 79, pp.233-238, August 1987; Joseph McLaughlin, et al., "Occupational Risks for Intracranial Gliomas in Sweden," *JNCI*, 78, pp.253-257, February 1987; and *MWN*, October 1984, July/August 1985 and March/April 1986.

Property Values Near Power Lines: Two Views

The controversy over the health risks of living near power lines is having an impact on property values in at least two states. The Fremont, CA, Planning Commission is requiring the California Department of Real Estate to warn potential

EPA on ELF Risks

In the appendixes to a new report on indoor air quality, the Environmental Protection Agency's (EPA) Office of Research and Development included a discussion of the health risks associated with exposure to ELF electromagnetic fields. Below are its conclusions, with the citations omitted:

There are data consistent with a possible connection between exposure to power line frequency electric and magnetic fields and 1) the appearance of cancer from basic biological changes in the utilization of genetic information, 2) to enhanced cellular transformations in test tubes, 3) reduced ability to resist immunological challenges, 4) an increase in human childhood cancer. In another area, effects have been shown on brain tissue *in vitro*, on brain tissue in animals exposed before they are born, and on certain behaviors of animals. Thus the specter of potential cancer induction/promotion and of aberrant behavioral changes has been associated with exposure to fields in homes caused by the electric power system and the use of home appliances. These reports do not unequivocally demonstrate that power line frequency fields are a human health hazard separate and apart from the known hazard due to electric shock and burns; however, the combined reports do indicate that a great deal of caution must be exercised before allowing any increase in exposure of the general population until a better understanding is obtained of the underlying mechanism of action and possible synergism with other potentially hazardous agents and stressors in the environment.

"Appendix A: Preliminary Indoor Air Pollution Information Assessment," *EPA Indoor Air Quality Implementation Plan*, EPA report No.600/8-87-014, June 1987, p.2-167.

home buyers in a subdivision that nearby 230 kV power lines may pose a health risk. The warning, which will be inserted in the department's final subdivision report, states that:

The subject property is located near Pacific Gas and Electric and the City of San Francisco High Voltage Electric Transmission Lines. Purchasers should be aware that there is ongoing research on possible potential adverse health effects caused by the exposure to a magnetic field generated by high voltage lines. Although much more research is needed before the question of whether magnetic fields actually cause adverse health effects can be resolved, the basis for such an hypothesis is established. At this time no risk assessments have been made.

According to an item in the Palo Alto *Times Tribune*, about ten of the 85 single-family homes will be 80-100 feet from the power lines. Sales are scheduled to begin in 1988.

Central Maine Power Co. takes a more optimistic view of the effect of power lines on real estate values. In response to questions raised by property owners, the company said that lots near transmission lines "have in many cases risen" in value. It attributed the increase to buyers' desire to be near cleared land exempt from property taxes.

SPARKS Fly in Ireland

An Irish citizens group called SPARKS (Stop Power Lines Across Residences, Kindergartens, Schools) has launched a campaign to stop the construction of 220 kV power lines which would run through playgrounds at two grammar schools in Wicklow County.

At a public meeting held in September, two local council members voiced their support for the group and said they would ask the council to push for a moratorium on building the lines until the health effects are studied. One council member has a child in one of the schools; the other said she "would not like her family or acquaintances to live near those pylons."

When the Electricity Supply Board applied for approval of the lines, it said that 1982 and 1984 World Health Organization (WHO) reports concluded that transmission lines up to 420 kV do not pose a health hazard. In response, SPARKS noted that a more recent WHO report took a more cautious view.

EPRI Radiation Newsletter

The Electric Power Research Institute (EPRI) has started publishing an occasional newsletter about its ionizing and non-ionizing radiation program. *Radiation Studies Review*, which will cover epidemiological studies, exposure assessment and mechanisms of interaction, will be issued three times a year.

At present, the four-page newsletter is available free. For more information, contact: Dr. Stanley Sussman, EPRI, PO Box 10412, Palo Alto, CA 94303, (415) 855-2581.

EXCERPTS

Congressional Power Lines Hearing Set for October 6

The House Subcommittee on Water and Power Resources will hold a hearing on the health risks associated with exposure to power line electromagnetic fields on October 6 in Washington, DC.

The lead-off witness will be Congressman Benjamin Gilman (R-NY). The 345 kV Marcy-South power line, which is under litigation, will run through his district (see *MWN*, March/April 1987).

At press time, the subcommittee is also scheduled to hear testimony from the following witnesses: Panel 1: Dr. Robert Becker, formerly of the VA Hospital in Syracuse, NY, Dr. Jerry Phillips of the Cancer Therapy and Research Foundation in San Antonio, TX, and Dr. David Savitz of the University of North Carolina in Chapel Hill. Panel 2: Dr. Ross Adey of the VA Hospital in Loma Linda, CA. Panel 3: Dr. Leonard Sagan of the Electric Power Research Institute (EPRI), accompanied by Dr. Philip Cole of the University of Alabama in Birmingham. Panel 4: Sheldon Meyers, the director of the Environmental Protection Agency's (EPA) Office of Radiation Programs, accompanied by EPA's Dr. Richard Phillips; and Donna Fitzpatrick, Assistant Secretary of Energy for Conservation and Renewable Resources.

Below are the opening statements by the members of the first panel on recent research on the biological effects of power line fields.

The hearing had originally been scheduled for September 22.

Robert Becker, MD

...It is my considered medical opinion, based upon my experience and knowledge in this field, that the biological effects of man-made electromagnetic fields (EMFs) constitute a health hazard to much of the population of the United States and that appropriate steps are urgently required to deal with this situation. This is a complex, new, scientific area and because of its environmental aspects and their economic and military impact, it has, unfortunately become politicized. One must have a basic understanding of the present scientific data and some knowledge of the past role of the federal government before any attempts are made to rectify the situation.

It is difficult to compress the knowledge and experiences of 30 years into a ten-minute statement; therefore, it should be understood that I will present a simplified overview of the situation under discussion.

When I began my research in 1958, science was certain it had buried forever the idea that electrical currents below the level of perception or external EMFs of any type had any important effects on living organisms. The accepted scientific doctrine was that the effect of EM energy on living organisms was identical to its effect on a bowl of Jello; simply heating it up only when very large amounts of power were applied. This subsequently became known as the "Thermal Effect Only" which, since it was fully in accord with the physics of the time and the biological idea that all living organisms were chemical machines, became scientific dogma. Those few scientists who reported valid experiments indicating bioeffects at levels far below the thermal were simply dismissed because true science knew that such effects simply could not occur. However, over the past 30

years this view has completely changed. We now know that very small electrical currents are generated by living organisms and that they are important regulators of growth and the operations of the central nervous system. Similarly, it has been discovered that the brain itself as well as other organs actually produce magnetic fields detectable outside of the body. Within the past decade we have found that living organisms have specific organs, developed very early in evolution, whose job it is to sense the changes that occur in the Earth's magnetic field and alter the organisms' behavior appropriately. Finally, only within the last year have we begun to begin to understand the actual physical mechanisms involved in these interactions between very small magnetic fields and living things. This area has grown from one in 1960 when less than a handful of scientists was involved to one today when we have three accredited scientific societies, two scientific journals devoted to this discipline in this country alone and literally thousands of scientists involved on a worldwide basis. The question no longer is one of "Do very small EM forces have any bioeffects?" but "What is the level of hazard from abnormal EM energy?"

Before 1900 the electrical environment of the Earth was far simpler than today, consisting primarily of the Earth's magnetic field, which, contrary to common misconception, is not constant but changes in strength at the same rate as the day-night cycle and also contains frequencies from below one per second to about 30 per second. This environment has existed since life began, so living things have had about three billion years to adapt to it and develop uses for it. Since 1900, we have markedly changed this environment with the introduction of fields and frequencies that never before existed on Earth. This use of EM energy for power and communications has markedly accelerated since the end of World War II and we have now just about filled up the available space in the EM spectrum. This change in our natural environment is actually the most drastic alteration made by mankind and is far greater than any chemical contamination yet produced. This was done in the complete confidence, based upon the "Thermal Effects Only" dogma, that no biological effects or actual harm to living things could occur. We now know that this was wrong. All living things are closely tied to the frequencies of our natural EM environment and the presence of abnormal, man-made fields produces serious alterations in basic life functions. It is important to contrast this effect with that of chemical pollutants which have specific actions on the body and result in specific diseases. Abnormal EMFs act at the most basic level of the organism and result in a wide spectrum of diseases and abnormalities. It is a fallacy to equate the two and require that field exposure produces specific diseases.

There are two large classes of effects of abnormal fields; those that impinge upon the total body functions and those that affect the function of single cells.

The first is produced because mechanisms and specific structures in the brain are "designed" to perceive the normal changes in the Earth's magnetic field for the purpose of furnishing a timing signal for biological cycles. This action is automatic and we are not aware of it. The pineal gland, buried deep within the brain, is sensitive to the normal cycle of magnetic field changes and alters its output of extremely important neurohormones in synchrony with them. These chemical messengers produced by the pineal govern the level of activity of the brain and regulate the functions of all of the body's glands. Chronic exposure to abnormal fields results in disturbances in the biological cycles which result in the production of the stress syndrome. This state of chronic stress is characterized by a wide variety of malfunctions in the organism, ranging from weight loss to

diminished capacity of the immune system and changes in brain function. Clinically, these result in declines in fertility, low birth weights, diminished resistance to infectious diseases, diminished resistance to cancers and increases in serious psychological disturbances.

The effect on cells is in the alteration of normal cell division. Exposure of any cell in active multiplication will result in an acceleration in the production of DNA and alteration in chromosome structure. These effects will be evidenced by a marked increase in the rate of cell growth and the production of genetic abnormalities. Clinically, the results will be, an increase in the incidence of birth defects and genetic diseases such as Down's Syndrome, increases in the growth rate and malignant characteristics of cancers and, quite possibly, the production of cancerous changes via genetic alterations.

It is instructive to look at the recent statistics for these general disease patterns in our society. The incidence of birth defects has approximately doubled over the past 25 years. The incidence of cancer in general is increasing approximately 1% per year and certain types have become epidemic in nature. In 1984, the NIMH reported the incidence of serious mental disorder in the general population was 20%, with the incidence in the under 45 age group at twice that figure. The incidence of suicide in the teen-age group had more than doubled between the years 1961 to 1981 and while firm data is not available, this increase seems to be accelerating. It is recognized that our society contains other factors that may contribute to this situation. However, the link with abnormal EMFs is the only one that extends globally to all of these conditions.

It is obvious that something needs to be done; however, before plans are made and actions taken, it is essential that the record of past actions by the regulatory agencies and other governmental entities be considered to avoid past mistakes. This record can only be characterized as either, at best, unintelligent adherence to the "Thermal Effects Only" dogma or, at worst, a deliberate cover-up motivated by military concerns.

Evidence of biological hazards from exposure to non-thermal levels of microwaves was known to the military since the late 1950s, however, the response was to deny its existence and to devise an exposure "standard" based upon the old "Thermal Effects Only" concept. To the best of my knowledge this same inadequate standard is in use today in all branches of the military. In the late 1960s the Navy was considering the construction of a very large antenna system for communicating with atomic submarines. This was to operate in the ELF band at either 45 or 75 Hz, just below and above the 60 Hz electric power frequency. A series of experiments were performed by the Navy and in December 1973, a committee of civilian experts, of which I was one, was convened to evaluate the results. There was no question that the results indicated a strong possibility of serious health hazards from the Navy's antenna system and, more so, from the civilian network of 60 Hz power transmission lines. In particular, the committee noted that the strength of the field from the antenna was a million times smaller than that from a 765 kV power line and it recommended to the Navy that this information be transmitted to the White House agency responsible for EM safety. The Navy responded by burying the report and denying its existence to Congress. Shortly after the meeting, I was informed of a proposal to build a network of ultra high voltage transmission lines in New York state. Since the report was not highly classified, I notified the Public Service Commission (PSC) of the state of its existence and suggested that they request the data from the Navy. This the Navy refused and the PSC contacted me directly with the request that I, and my colleague, Dr. Andrew Marino, serve as expert witnesses in a public hearing on this question. Delays imposed by the utilities

involved permitted us to conduct additional experiments at the 60 Hz power frequency, which extended and confirmed the risks found in the Navy studies. The hearings began in 1976 and during their course all grant funding from both the NIH and the VA was withdrawn from my laboratory. On separate occasions both Dr. Marino and I were informed by representatives of the VA that our withdrawal from the hearings would result in restitution of the funding (later I was told by an admiral and former Chief of the Office of Naval Research that the Navy protested the closing of my lab in this fashion but was overruled). I refused to withdraw and the laboratory was closed in December 1980. However, the PSC accepted and implemented my recommendations for a long-term research program, which I made during the hearings. This resulted in the New York Department of Health's Power Lines Project.

...Despite the fact the New York report noted some positive findings and one of its recommendations has been the occasion for this hearing, the majority of it...[has] deficiencies....These defects include the application of extremely rigorous requirements to positive reports while accepting negative reports at face value, ignoring significant positive reports in the literature, using non-applicable negative reports, etc. In short, all studies done to date by public agencies with public funding have been biased, unscientific and designed to indicate a lack of harm from these EMFs.

Large amounts of public funds have also been used for many animal experiments purportedly designed to evaluate the health risks associated with such fields. Most have actually been designed, deliberately in advance, to yield negative results and any positive results obtained have not been reported or their release has been long delayed. In such contract research the "Golden Rule" applies - "He who has the gold makes the rules." In short, despite the expenditure of many millions of dollars, the actions of federal and state agencies have been not only far less than adequate to deal with this issue but suspect as well.

This is not simply a scientific issue but a very human one. A family living on a dairy farm in New York that has been theirs since 1820 has suffered an economic and medical disaster. A 765 kV transmission line was built through their land a few hundred feet from their home. Since it began operating in 1982, their cows have produced dead or defective calves and all of their chickens produced defective, unsalable eggs and then died. Their young daughter developed Hashimoto's disease, a permanent autoimmune condition of the thyroid gland, and the husband and son have developed other autoimmune diseases. Their farm is unsalable and cannot be used for collateral for them to be able to move. I called this situation to the attention of the NY-DOH Panel, suggesting that it be studied and that other similar-case situations be looked for. They took no action whatsoever. Since 1981 I have worked with a citizen's group in a rural town of about 25,000 inhabitants in New Jersey. This town ranks fifth in the nation in the concentration of microwave sources, behind New York City, Chicago, Dallas and San Francisco and just ahead of Los Angeles. The first microwave source began operating in 1974 and 11 months later the first baby with Down's Syndrome was born. Since then the microwave sources have increased, and so have the cases of Down's Syndrome until at this time the incidence is at least five times greater than normally expected. Furthermore, these cases are located in "clusters" along with other genetic and birth defects and an excess of cancers. These cluster areas appear to be locations irradiated by the local microwaves. Studies have been made and reports issued by the New Jersey Department of Health, the EPA and the CDC, none of which adequately addressed the problem. I have provided the sub-committee with a copy of a scientific report I recently published on this situation. At this time, basically nothing is being done.

EXCERPTS

I urge the establishment of a congressionally mandated and overseen research program aimed specifically at determining the level of risk. Whether this research program is based in a federal agency or not, it must be overseen by a panel of outside experts, drawn from many disciplines, and must include full representation by advocates for the position that such irradiation may be harmful. Full and prompt disclosure of all data and all panel deliberations and decisions must be assured. I also urge consideration of a congressional investigation of human exposure in the military forces of the U.S., and consideration of a moratorium on new construction and operation of field-producing military facilities. I am well aware of the vital role played in our society by EM forces and in no way do I advocate total cessation of their use. I urge only that risk-benefit decisions in this area be based upon valid scientific data and be made by representatives of the population at risk rather than by parties of interest. It is time to seek the truth about this vital problem.

Jerry Phillips, PhD

...Although cancer is only one aspect of electromagnetic field (EMF) effects on human health and development, it is the one with which I am most familiar and which I will discuss with you this morning.

Prior to the 1979 report of Wertheimer and Leeper, which documented an association between long-term exposure to low-level household-frequency or 60 Hz EMFs and childhood leukemia, interest in EMFs and cancer in general was minimal. However, Wertheimer and Leeper's hypothesis was unique, startling and potentially frightening. Suddenly, it was possible that exposure to EMFs produced by the flow of 60 Hz electricity could be a hazard to human health. In the years following Wertheimer and Leeper's report, many additional reports have appeared in which the theme has been the same: exposure to low-level 60 Hz EMFs in the home or on the job appears to be associated with increased incidences of leukemia in children and various cancers in adults. However, the epidemiological studies are just one link in an important chain of evidence; there are also laboratory studies which form an important bridge between epidemiology and a real-world increase in cancer incidence caused by EMFs.

Before describing these laboratory studies, let me first present some basic information about cancer. Most human cancers are triggered or propagated by exposure to environmental agents. Therefore, cancer development is the result of a complex interplay between various chemical and physical agents and unknown factors dictated by human genetics. The natural history of cancer development evolves through stages that include initiation and promotion. Initiation is a process that results in the transformation of a normal cell into a cancer cell, and involves at least one permanent, heritable alteration in the basic structure of the cell's genetic information (its DNA). Promotion is a process characterized by selective growth and altered gene expression of the initiated cells (stem cells). After the initiation occurs, the tumor response is ultimately the same, whether promotion occurs one week or one year later. These distinctions are important, because the available scientific literature indicates that EMFs appear to serve as tumor promoters. The question, therefore, is not whether 60 Hz EMFs cause cancer, but rather what is the extent to which such fields contribute to the development of clinical cancer?

The available scientific data indicate that EMF exposure has effects that are both direct (i.e., on human cancer cells) and indirect (i.e., on other body cells, but having the overall effect of allowing cancer development). In the former category are studies from my laboratory. We have found that human cancer cells exposed to 60 Hz EMFs: 1) exhibit two- to 24-fold greater growth of stem cells; 2)

exhibit increased expression of a growth-related cellular protein; 3) exhibit greatly increased resistance to destruction by cells of the body's defense system; and 4) these changes are permanent. These results are especially important since the key events in tumor promotion are associated with increased growth and altered gene expression in initiated stem cells. Further support comes from other laboratories, where research has indicated that EMF exposure of human and other cells changes the activity of key growth-related enzyme systems, increases the rate of DNA synthesis and alters the expression of key cellular genes.

As mentioned previously, indirect effects also may be responsible for the tumor-promoting ability of EMFs, and the most important of these effects is a decrease in the capacity of the cells of the body's immune or defense system to function properly. This can occur in two ways. First, it has been shown that EMF exposure can affect white blood cells directly, causing a decreased ability to proliferate or a decreased ability to destroy cancer cells. Alternatively, long-term exposure to EMFs has been shown to act as a general source of stress. Therefore, exposure to EMFs may influence the activities of cells of the central nervous system and cells of other hormone-secreting tissues, resulting in a depression of the body's defense system and providing fertile ground for cancer growth. In this regard, it has been known for many years that chronic administration of many drugs that suppress immune function is associated with an increased risk of cancer, particularly leukemia. Why, then, can't a similar situation arise from chronic exposure to EMFs?

To summarize: Laboratory studies by various investigators have demonstrated that mechanisms do exist to explain how real-world exposure to 60 Hz EMFs can result in an increased incidence of human cancers. Furthermore, we have a situation in which, because of EMF exposure, not only do cancer cells grow and become tougher, normal cells of the body's defense system have a decreased ability to fight them as well.

While good studies, as described above, have been performed by competent scientists, many gaps in our present knowledge remain. These could have been plugged if sufficient funding were available in years past. Obviously, therefore, we need to start plugging those gaps now with a stable, federally-funded program. The potential hazards associated with long-term exposure to EMFs appear to be severe, and the need to know the exact nature and boundaries of the problem becomes more urgent as power distribution systems worldwide continue expansion through residential areas, exposing increasing numbers of unsuspecting individuals to EMFs.

Let me close with two additional comments for committee members. First, be critical about not only what you hear and read, but also about the individual providing you with the information. In learning about human health effects of EMF exposure, for instance, one should consult with scientists who have knowledge of bioelectromagnetics as well as of a pertinent discipline, such as epidemiology, physiology, cell biology or medicine. However, in areas relating to human health and biology, one should exercise great caution in consulting with plant or poultry scientists or with engineers, whose training, actual occupational experiences and expertise may be severely limited. Second, exercise caution when you are told that certain studies are to be discounted because they have not been replicated or that data obtained in more than one laboratory for similar experiments indicates "no consistent effect." Such statements are best debated in the scientific, not political, arena. Furthermore, experiments in which exposure to EMFs has produced no effects are just as important as experiments in which exposure has produced effects, since science must involve both types of experiments to determine when and to what extent such effects occur.

It is beyond question that exposure to EMFs produces changes in

biological functions. The issue of hazards to human health and development signalled by these changes must be addressed. It cannot be ignored any longer; the science must be done. If a link is demonstrated between exposure to EMFs and adverse effects on human health, the potential liability faced by utilities, land developers and municipalities will be staggering unless a conscious effort is made to protect the public. We must determine what the hazards are and the extent to which they occur and develop methods to mitigate those hazards that exist.

David Savitz, PhD

...We began our study of the relationship between electric and magnetic fields (EMFs) from power distribution lines and childhood cancer risk in December 1983, at the University of Colorado. At that time, the pertinent research consisted of studies of childhood and adult cancers in the Denver area which suggested an association between electrical wiring and cancer occurrence, a negative report from Rhode Island and an additional study suggesting an association conducted in Stockholm, Sweden. Those studies all suffered from possible deficiencies in their design, especially in regard to exposure measurement, and their lack of information on other cancer determinants. Nonetheless, no one has been able to explain how these problems could have spuriously produced the reported pattern of results.

Our study in Denver...was a case-control study in which exposure patterns of children with cancer were compared to those of the community in which they resided. All 356 children aged 0-14 who lived in the Denver area and were diagnosed with any form of cancer during the period 1976-1983 were eligible for inclusion in the study. For comparison, 278 children of similar age, sex and area of residence were identified as controls. For as many children as possible, measurements of EMFs were taken in the home and the electrical wiring patterns in the vicinity of the home were recorded as indirect measures of the long-term 60 Hz magnetic field levels. One of the important findings was that characteristics of outside power lines are an important determinant of the magnetic fields in the home. Given our focus on the Denver area, very few homes (10 out of over 700) were in close proximity to high tension lines, such that the study results are derived from neighborhood distribution lines. It should also be noted that we were not concerned with the wires within a home or those serving a home, but with the distribution lines going past the home.

Magnetic fields measured with the house power turned off (to isolate the fields from outside lines) were found to be associated with cancer risk, with a 40% increase for homes above 2.0 milligauss (a magnetic field measure). Stronger associations were seen for leukemias, lymphomas and soft tissue tumors. Magnetic field measurements with the house power turned on and electric field measurements were not associated with cancer risk in our study. Wire configuration codes (as a surrogate for magnetic fields from outside power lines) were more convincingly related to childhood cancer risk: a 50% greater incidence of childhood cancer was found in association with higher current configurations. The contrast of highest to lowest exposure groups based on wire codes suggested a 2.3-fold increase in cancer incidence associated with the highest exposure. None of these results were changed by consideration of a number of other cancer risk factors such as parental smoking, income, education, medications during pregnancy and X-ray exposures. The major limitations to the study conclusions come from the incomplete response, uncertainty about the accuracy of exposure characterization and possible biases in the manner in which controls were selected. There is no reason, however, to suppose that these

uncertainties would diminish rather than enhance the observed associations.

Our study in Denver clearly provides additional evidence that 60 Hz magnetic fields may pose a hazard. Some of the deficiencies of previous studies were remedied in this investigation and yet the pattern that others had reported remained. Most reviewers of the scientific evidence, however, find that the data from the Denver study and the other investigations fail to provide convincing evidence that magnetic fields cause cancer in human populations. The epidemiologic and laboratory research have progressed sufficiently to provide important suggestive evidence of a possible health hazard and demonstrate that meaningful research can be done which will advance our knowledge. Some suggestions for future studies are offered below.

One concern is with the scarcity of evidence from experimental studies regarding exactly how such fields would operate to produce increased cancer frequency. Interesting hypotheses and preliminary data have been gathered, but additional work is needed. In the realm of epidemiology, there is a clear need to replicate and improve upon our study of childhood cancer. Some research is in progress, including studies of childhood cancer in Los Angeles (supported by the Electric Power Research Institute [EPRI]) and studies of childhood and adult cancers in Sweden and England. In addition, research into possible carcinogenic effects of 60 Hz magnetic fields among electric utility workers is being conducted by a consortium of Canadian and French utilities as well as in a study of American electric utility workers (also supported by EPRI) which I direct. All these activities should be informative, but none of the current funding sources will be capable of mounting the large-scale effort warranted to provide more definitive data on childhood cancer risk. With the experience of our study and other past studies, we have learned enough about the approach to this issue to argue that a large, multi-center study of specific cancer types which expands upon our assessment methods would be capable of overcoming many of the limitations and uncertainties in our work. Traditionally, only the federal government has been capable of supporting such efforts.

In the area of health effects from 60 Hz EMFs, the epidemiologic data are the principal stimuli for additional research, in spite of uncertainty about biological mechanisms of effect. Historically, there have been agents which were known carcinogens based on human studies long before a laboratory demonstration of the effect could be shown (e.g., benzene, arsenic). Given the suggestive (though not conclusive) epidemiologic studies and the tremendous potential public health impact, resolution of this issue is a worthy goal. The widely cited calculation that 10-15% of all childhood cancers could be due to magnetic fields from power lines was often noted without the necessary caveats, but: 1) if the association we found reflects a causal relationship and 2) if the exposure pattern in other areas is similar to that in Denver, then a sizable proportion of childhood cancers would be related to this exposure.

There has been little enthusiasm among government research agencies for funding this area of investigation. My perception is that the uncertainty regarding biological mechanisms discourages scientists who have been most interested in issues such as ionizing radiation, for example, where the carcinogenic mechanisms are relatively well understood. The electric utility industry has provided indirect support (through the New York State Power Lines Project and EPRI) for most of the epidemiologic work in recent years. It seems essential for the federal government to assume a more active role, given the magnitude of the potential public health impact and the scale of possible future efforts to reduce exposures. Even if additional research efforts provided clear evidence that no hazard is present, the effort would still be warranted.

UPDATES

COMPATIBILITY & INTERFERENCE

EMC in Europe & TEMPEST in U.S....Frost & Sullivan, Inc. (F&S), the market research firm, predicts healthy growth – from \$194 million in 1986 to \$511 million in 1993 – for EMC products and services in Europe; at present, by far the largest European sales are in the U.K. and in West Germany. This growth will come in part from the increasing emphasis on designing EMC into electronic systems, according to F&S. The 384-page report, *Electromagnetic Compatibility Products and Services Market in Europe* (No.E892), is available for \$2,600 from F&S, 106 Fulton St., New York, NY 10038, (212) 233-1080....In another study, F&S anticipates that the military market for TEMPEST equipment will continue to grow and reach \$2.9 billion in 1992, up from \$874 million in 1986; though the specific numbers are different, the trend agrees with the predictions of International Resource Development, Inc., in its recent report on the TEMPEST market (see *MWN*, May/June 1987). According to the F&S report, the largest growth will be in the sales of secure telephones. Wang, AT&T and Digital Equipment have the largest shares of the TEMPEST market. *The Military TEMPEST Equipment Market in the U.S.* (No.A1774), which is 248 pages long, is available for \$1,950 from F&S....Nancy Whelan explores some of the reasons for the huge growth in TEMPEST products in "TEMPEST and Computer Security," which appears in the September issue of *Government Executive*, published by the *National Journal* in Washington, DC.

ESD Fuel Ignition...The U.S. Army Research Office has awarded a \$120,000 contract to Electro Magnetic Applications, Inc., in Denver, CO, for a three-year, in-depth investigation of electrostatic discharge (ESD) ignition of solid fuel rocket propellants. Dr. Ronal Larson is the principal investigator in this effort. (See also story on ESD and HERO risks on p.2.)

GOVERNMENT

Clarifying FCC's RF/MW Rules...Hammett & Edison (H&E), Inc., a consulting firm based in San Francisco, CA, has asked the FCC to clarify its rules for determining when an environmental assessment related to RF/MW radiation safety is needed for license applications and renewals (see *MWN*, April 1985 and March/April 1987). In a July 23 filing, H&E's Dane Ericksen asked the FCC to review three issues related to dealing with multiple sources and re-radiating metallic objects, proposing amendments to the FCC's regulations. H&E suggested that: (1) Broadcast sites that are near other antennas should be treated as separate sites if the nearby antennas contribute 5% or less of the ANSI limits at the sites' boundaries; (2) Low-power transmitters that contribute less than 5% of the ANSI limits at a site should be considered as "not significantly affecting the environment" – thereby, not requiring an environmental assessment; (3) In field surveys, probes should not

be placed closer than 20 cm to any re-radiating metallic objects. In each case, H&E asked that, if the FCC disagrees with the triggers specified in its proposal, the commission should adopt conceptual versions of these amendments, substituting its own triggers. The FCC is treating H&E's proposal as a petition for rulemaking and has asked for public comments; these are due on October 30, with reply comments due on November 20. For more information, contact: Dr. Robert Cleveland, FCC, 2025 M Street, NW, Washington, DC 20554, (202) 653-8169.

MEASUREMENT

Biomedical Applications...Drs. Maria and Stanislaw Stuchly have written a comprehensive review, "Measurements of Electromagnetic Fields in Biomedical Applications," covering ELF and RF/MW electric and magnetic fields for both external and internal probes. The 47-page article, with 122 references, appears in the *CRC Critical Reviews in Biomedical Engineering*, 14, pp.241-288, 1987....A research group from the University of Utah in Salt Lake City has used a computer model to calculate near-field absorption by a spherical model of a human in the resonant frequency range. See Magdy F. Iskander and coworkers in the *IEEE Transactions on Microwave Theory and Techniques*, 35, pp.776-780, August 1987.

New From NBS...Three recently published reports from NBS's Electromagnetic Fields Division evaluate antenna measurement errors. Lorant Muth examines how moving probes can cause variations in *Displacement Errors in Antenna Near-Field Measurements and Their Effect on the Far Field* (TN 1306), which is available for \$2.00, prepaid, from the U.S. Government Printing Office (GPO), Washington, DC 20402; order No. 003-003-02776-6. M. Kanda and J. C. Wyss's *Evaluation of Off-Axis Measurements Performed in an Anechoic Chamber* (TN 1305) shows that if the receiving and source antennas are misaligned in an anechoic chamber, inaccuracies can result. A copy can be ordered for \$2.25, prepaid, from the GPO; order No. 003-003-02779-1. In *Out-of-Band Response of Antenna Arrays* (NBSIR 86-3047), David Hill and Michael Francis report on near-field measurements from two large arrays of slotted waveguides. The report is available for \$11.95, prepaid, from the National Technical Information Service, Springfield, VA 22161; order No. PB 87-125746/AS.

MEETINGS

Zurich EMC Symposium...More than 115 papers from 28 countries were presented at the biannual *7th International Zurich Symposium and Technical Exhibition on Electromagnetic Compatibility*, which was held March 3-5, 1987. The 658-page proceedings, edited by Dr. T. Dvorak, are available for 100 Swiss francs (including postage) from EMC Symposium, ETH Zentrum-IKT, 8092 Zurich, Switzerland. The 8th

symposium is planned for March 1989 and the first call for papers will be mailed out this December.

IRPA Workshop... Those going to the International Radiation Protection Association's congress (IRPA-7), to be held in Sydney, Australia, April 10-17, 1988, may want to arrive a few days early to attend a special *International Non-Ionizing Radiation Workshop*, which will be held April 5-8 in Parkville, Victoria, a suburb of Melbourne. The registration fee is \$200.00 Australian, approximately \$140.00 U.S. After February 1, the cost will go up to \$250.00 Australian. For more information, contact: Dr. C. Roy, NIR Section, Australian Radiation Laboratory, Lower Plenty Rd., Yallambie, Victoria 3085, Australia.

EMC in Paris... The International Electrotechnical Commission (IEC) is sponsoring a workshop on *Electromagnetic Compatibility Standardization in the IEC*, December 14-16, in Paris, France. Various committees of the IEC are developing EMC standards and their work is being coordinated by the IEC's Advisory Committee on EMC. The Paris workshop is designed for those interested in the latest activities of these myriad groups. Among the subjects to be covered are power networks, information technology and broadcasting services – from ELF to millimeter waves. Registration costs 700 French francs. Contact: Comité Electrotechnique Francais, 12 Place des Etats-Unis, 75783 Paris Cedex 16, France, (1) 47-23-72-57.

OCCUPATIONAL HEALTH

Long-Distance Hazards... Ten employees of Mountain Bell, a subsidiary of US West, in Idaho Falls, ID, have reported symptoms ranging from dizziness to loss of memory to cataracts. One worker suffered a stroke. The employees, who test microwave toll and long-distance equipment, are represented by the Communications Workers of America (CWA), which asked NIOSH to conduct a Health Hazard Evaluation last February. Radiation measurements were made, but David LeGrande, the CWA's coordinator for occupational safety and health, told *Microwave News* that he is "dissatisfied" with NIOSH's survey. He criticized the agency for not taking enough measurements and for sending a physician who had little knowledge about microwave effects. In a telephone interview, Dr. Bobby Gunter of NIOSH's Denver office, who visited the Idaho site, said that he found no overexposures and that the site was "one of the safest" he has seen. Gunter sent his report to NIOSH headquarters on July 31, where it will be reviewed before being released.

OVENS

FDA Nabs Leaky Units... In July, during routine testing of a new line of microwave ovens manufactured by Samsung in South Korea, the FDA's compliance office found that a

prototype failed to pass the agency's radiation emission tests. A staffer at the FDA's Center for Devices and Radiological Health told *Microwave News* that the design problems were caught before any of the imported ovens reached consumers. Following some changes, including the design of the door latch, the ovens met the FDA's leakage requirements and were cleared for marketing.

PEOPLE

On January 1, 1988, NIEHS's Dr. Don McRee will take over from EPA's Dr. Richard Phillips as the editor of *Bioelectromagnetics*. By the time he steps down, Phillips will have completed four volumes of the journal...Dr. David Davidson, a physicist at GTE Laboratories, Inc., in Waltham, MA, died in June. Well known to the bioeffects community, Davidson, who was one of the developers of the LORAN navigational system, was an active participant in IEEE, ARRL and ANS C95 activities.

POWER LINES

Fertility of Cows... Exposure to 50 Hz electric and magnetic fields has no consistent effect on the fertility of cows, according to a series of studies at the Department of Animal Hygiene of the Swedish University of Agricultural Sciences in Skara. A preliminary study, released in 1981, indicated that dairy cows exposed to 400 kV lines for less than 11 days a year (the average was 7 days) showed no change in fertility, but that those exposed for approximately 25 days suffered decreased fertility. A subsequent epidemiological study appeared to contradict the earlier finding: Herds exposed to 400 kV lines for more than 15 days a year "revealed no reduced average fertility as far as can be seen from artificial insemination results." Last year, the Skara team announced that a controlled study of 58 heifers – exposed continuously for 120 days to an average unperturbed electric field of 4 kV/m and to a magnetic field of 2 μ T – showed no changes in "ovarian activity, intensity of estrous [being in heat] signs, pregnancy and fetal viability." Nor did the group find a consistent effect on the cows' circadian rhythms. The reports and papers include: Bo Algers, Ingvar Ekesbo and Katarina Hennichs, *The Effects of Ultra High-Voltage Transmission Lines on the Fertility of Dairy Cows: A Preliminary Study*, Report 5, 1981 (in Swedish, with an English summary); Hennichs, *Cows Exposed to 400 kV Lines: Inventory and Fertility Study*, Report 7, 1982; Algers and Hennichs, "Biological Effects of Electromagnetic Fields on Vertebrates: A Review," *Veterinary Research Communications*, 6, pp.265-279, 1983; Algers and Hennichs, "The Effect of Exposure to 400 kV Transmission Lines on the Fertility of Cows: A Retrospective Cohort Study," *Preventive Veterinary Medicine*, 3, pp.351-361, 1985; and Algers and Jan Hultgren, *Effects of Long-Term Exposure to a 400 kV, 50 Hz Transmission Line on Estrous, Fertility and Diurnal Rhythm in Cows*, Report 15, 1986. For more information, contact: Bo

UPDATES

Algers, Research Manager, Department of Animal Hygiene, Faculty of Veterinary Medicine, Swedish University of Agricultural Sciences, PO Box 345, S-532 00 Skara, Sweden.

HVDC Agricultural Effects... Studies are also underway at the DOE's Bonneville Power Administration's (BPA) Grizzly Mt. HVDC Research Facility to determine the possible impact of a ± 500 kV DC line on cattle and crops. According to the just-released, second annual report of the three-year *Joint HVDC Agricultural Study*, no deleterious effects have been found. Robert Raleigh of Oregon State University is the principal investigator on the project, which is being supported by a number of utilities, as well as by EPRI. A final report is due in 1988. For more information, contact: Jack Lee, Jr., Biological Studies Coordinator, BPA, PO Box 3621 (EVRE), Portland, OR 97208.

VDTs

Australian, Finnish and German Measurements... According to a survey by staffers at the Australian Radiation Lab, the highest VLF electric and magnetic fields at 30 cm from a VDT screen were 15 V/m and 90 mA/m ($0.1 \mu\text{T}$), respectively – though the levels were usually much lower. The researchers found that the fields decreased very quickly with distance from the VDT and were unaffected by the display color. Only background levels of ionizing radiation were identified. The Australians did not measure either ELF fields – “because it was thought that they are not a hazard in the office environment” – or electrostatic fields – “There is no evidence...to support the suggestion that electrostatic fields from VDTs are linked to [facial skin rashes].” See G. Elliott, C.R. Roy, H.P. Gies and K.H. Joyner, “Video Display Terminals and Radiation Emissions – Current Status,” *Radiation Protection in Australia*, 4, pp.123-130, 1986. Previously, the same group published “Electromagnetic Radiation Emissions from Video Display Terminals (VDTs),” *Clinical & Experimental Optometry*, 69, pp.53-61, March 1986, which contains measurement data on over 50 different VDT models. (Dr. Joyner has since left the radiation lab to join Australia's Telecom Research Labs)...Finnish researchers have measured the ELF and electrostatic fields from seven VDTs, however. Jukka Juutilainen and Keijo Saali, of the University of Kuopio, report that the 50/60 Hz signal from the vertical deflection coil has a triangular waveform and dominates over the sinusoidal 50/60 Hz field everywhere except in the vicinity of the power transformer. The ELF field varied from 0.2-0.65 A/m ($0.2-0.8 \mu\text{T}$) and from 0.05-0.22 A/m ($0.06-0.26 \mu\text{T}$) at 30 and 50 cm, respectively. The background levels in the offices were on the order of 0.01-0.07 A/m (12-84 nT), though in one case the background was as high as 0.15 A/m ($0.18 \mu\text{T}$). The team found that the VLF signal was “clearly weaker” than the 50/60 Hz signal in all the tested models. These results appear in the *Scandinavian Journal of Work and Environmental Health*, 12, pp.609-613, 1986. In a second paper due to appear

this year in the same journal, Juutilainen and two associates report that the measured electrostatic field from a VDT “was highly dependent on the method of measurement.” They conclude that, for distances of 10-40 cm from a VDT, “there is no simple relationship between field strength and distance. The exact relationship depends on the shape and size of the measuring system and the screen.” Using what the group found to be the most reliable measurement system on ten VDTs, at 30 cm the electrostatic field varied from 0 to 40 kV/m....A German computer magazine, *P.M. Computerheft*, reviewed the safety of VDTs in its May/June issue. Electrostatic, electric and magnetic fields, as well the time rate of change of the magnetic field, were measured for 16 different types of VDTs.

Canadians on Radiation... The Canadian Centre for Occupational Health and Safety (CCOHS) has just released *Emissions from Video Display Terminals and Their Measurement – A Training Manual*, by Dr. Karel Marha, Bhawani Pathak and David Charron. It covers the design of a VDT, the types of radiation emissions, their measurement and their possible biological effects. The report, No. P86-19E, is available for \$3.25 U.S. or \$3.00 Canadian, prepaid, from CCOHS, 250 Main St. East, Hamilton, Ontario L8N 1H6, Canada, (416) 572-2981 or (800) 263-8276....The Canadian Labour Congress (CLC) has released a 14-page report, *Fighting the Radiation Hazards of VDTs*, which argues that ELF and VLF fields from VDTs “are definite cause[s] for concern” (CLC's emphasis). The group recommends that more attention be devoted to finding alternatives to CRTs and strongly advocates reducing VDT emissions “at the source” and granting pregnant workers the right to alternative work. The report is in English and in French.

Epi Studies Begin... Two major VDT epidemiological studies are underway. In July, the National Institute for Occupational Safety and Health (NIOSH) started collecting data for its long-awaited epidemiological study of reproductive risks among VDT workers. Dr. Teresa Schnorr, lead researcher on the study, said that she expects a better than 70% response rate from the 4,000 AT&T and BellSouth women participating. However, others, including Dr. William Butler, co-director of the University of Michigan VDT epidemiological study, think this is an overly optimistic view, as the women are being interviewed at home by phone – a method which generally produces fewer responses than do face-to-face interviews. The study will not include stress and fertility questions which the Office of Management and Budget (OMB) ordered deleted last year (see *MWN*, September/October 1986). Researchers at the Mt. Sinai Medical Center in New York City have received funding from NIEHS for the first phase of their study on miscarriage risks among office workers (see *MWN*, June 1985 and May/June 1987). The study will be the first to monitor office workers during their pregnancies, rather than retrospectively. The pilot study will cost \$30,000.

ETC...

Coffee On the Go...Coffee from the microwave just got better: now you can have it fresh-brewed, thanks to a disposable container called Micro-Cup. Just put your favorite fresh-ground coffee in one of the container's chambers and water in the other, place the Micro-Cup on top of a mug and put it in the microwave. Voilà! In minutes, freshly brewed coffee. According to Gary Grossman, president of Innovations & Development Inc., in Edgewater, NJ, the manufacturer of the Micro-Cup, "This is the first product to combine the taste of fresh-brewed coffee with the convenience of instant." Coffee is the most commonly microwaved food in America.

Vision, Stealth (continued from p.1)

rhodopsin: the straightening out of the retinal molecule (from *cis* to *trans*) is the key to all vision. Now, Birge has found that other small changes in the conformation of retinyl Schiff bases – the movement of a counterion from one spot on the molecule to another – can result from the absorption of specific types of RF/MW radiation.

Henry Kues of the Johns Hopkins University Applied Physics Lab (JHU-APL) in Laurel, MD, said that Birge's findings "...could explain how microwaves are being absorbed in the eye. It's a possible answer and it would make sense." JHU-APL's Dr. Sam Koslov agreed: "It's a possible mechanism to explain the production of free radicals," he said in a telephone interview.

Kues has shown that low levels of pulsed 2.45 GHz radiation can affect the biochemistry of a monkey's eye. "We are gearing up to investigate the Schiff base connection," he said.

Birge's assistant told *Microwave News* that Birge "is no longer accepting any calls" on this work – which was originally funded by civilian agencies, the National Institutes of Health (NIH) and the National Science Foundation (NSF). Birge also refused to respond to queries concerning the biological implications of his findings.

On learning of the secrecy order, another bioeffects researcher said, "It's a shame; it could have interesting implications."

See: Robert Birge, et al., "Two-Photon, ¹³Carbon and Two-Dimensional ¹H NMR Spectroscopic Studies of Retinyl Schiff Bases, Protonated Schiff Bases and Schiff Base Salts: Evidence for a Protonation Induced $\pi\pi^*$ Excited State Level Ordering Reversal," *Journal of the American Chemical Society*, 109, pp.2090-2101, 1987; Malcolm Browne, "Vision Chemical Is Found To Absorb Radar," *New York Times*, August 18, 1987; Henry Kues, et al., "Effects of 2.45 GHz Microwaves on Primate Corneal Endothelium," *Bioelectromagnetics*, 6, pp.177-188, 1985; Lubert Stryer, "The Molecules of Visual Excitation," *Scientific American*, July 1987; George Wald, "The Molecular Basis of Visual Excitation," *Nobel Lectures: Physiology or Medicine* [1967], Amsterdam, Holland: Elsevier, 1972; "New Materials Promise Low Radar Reflectance," *Aviation Week & Space Technology*, May 18, 1987; "Visions of an Invisible Aircraft," *Science News*, August 29, 1987; and *MWN*, September/October 1986 and July/August 1987.

The Protective Watch...Some years ago, a Pentagon official reported that he protected himself from ELF electromagnetic fields by wearing a matchbook-size ELF generator (see *MWN*, May 1982). Now you too can have the same kind of protection. Manufacturers of a new watch, called the Teslar, claim that it can shield against these fields and improve the way you feel. According to Andrija Puharich, the developer of the Teslar, the watch has a magnetic wafer which not only attracts and traps ELF waves but also aligns the body's system with its "natural frequency." All this for only \$79.00. And you don't have to forgo fashion for health; the Teslar comes in digital and traditional styles, for men and women.

Conference Calendar

New Listings for 1988

March 30-31: 24th Annual Meeting of the National Council on Radiation Protection and Measurements (NCRP), Washington, DC. Contact: NCRP, 7910 Woodmont Ave., Suite 1016, Bethesda, MD 20814, (301) 657-2652.

May 10-12: EMC Expo-88, Hilton & Towers Hotel, Washington, DC. Contact: EMCExpo-88, PO Box D, Gainesville, VA 22065, (703) 347-0030.

May 14-18: 23rd Annual Meeting & Exposition of the Association for the Advancement of Medical Instrumentation (AAMI), Sheraton Washington Hotel, Washington, DC. Contact: Debbie Trittle, AAMI, 1901 North Fort Myer Dr., Suite 602, Arlington, VA 22209, (703) 525-4890.

May 16-19: 20th Annual Meeting of the Conference of Radiation Control Program Directors (CRCPD), Hyatt Regency, Nashville, TN. Contact: CRCPD, 71 Fountain Pl., Frankfort, KY 40601, (502) 227-4543.

May 16-20: 1988 Nuclear EMP Meeting, SRI International, Menlo Park, CA. Contact: K.F. Casey, JAYCOR, 39650 Liberty St., Suite 320, Fremont, CA 94538.

May 25-27: 1988 IEEE MTT-S International Microwave Symposium, New York, NY. Contact: Jesse Taub, LRW Associates, 1218 Balfour Dr., Arnold, MD 21012.

Upcoming Meetings

November 2-5: DOE/EPRI Review of Research on Biological Effects of 50/60 Hz Electric and Magnetic Fields, Air Ions and Ion Currents, Hyatt Regency Hotel, Kansas City, MO. Contact: W/L Associates, Suite #4, 120 West Church St., Frederick, MD 21701, (301) 663-1915.

November 9-12: 32nd Annual Conference on Magnetism and Magnetic Materials, Marriott Hotel, Chicago, IL. Contact: Dr. John Scott, American Institute of Physics, 335 East 45th St., New York, NY 10017.

November 10-12: 2nd Annual Society of Broadcast Engineers (SBE) National Convention and Broadcast Engineering Conference, A.J. Cervantes Convention Center, St. Louis, MO. Contact: SBE, PO Box 16861, St. Louis, MO 63105.

November 13-16: 9th Annual Conference of the IEEE Engineering in Medicine and Biology Society, Park Plaza Hotel, Boston, MA. Contact: Dr. Ronald Newbower, Dept. of Biomedical Engineering, Massachusetts General Hospital, Boston, MA 02114, (617) 726-1676.

December 13-18: Symposium on Hyperthermia, Boston, MA. Held in conjunction with the ASME Winter Annual Meeting. Contact: Prof. Bob Roemer, Dept. of Aerospace and Mechanical Engineering, University of Arizona, Tucson, AZ 85721, (602) 621-6112.

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