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THE INVISIBLE THREAT



The Stifled Story of Electric Waves



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STEVE NIEDORF/THE IMAGE BANK

The Stifled Story of Electric Waves

Radar screen—ghostly intruder in private homes.

by Susan Schiefelbein

IN THE HEART OF THE American midwest, a farmhouse is nestled in the land just adjacent to a military base. Although the enlisted men use the post as a practice area for electronic warfare, the base had never bothered the farmer and his wife much, at least not until recently. Then the wife began to lose her memory. Soon she also had problems with her sight. One evening, when she entered her son's darkened bedroom, the desk lamp lit up—by itself. She unplugged it, but its eerie light continued to glow. Perhaps, it occurred to her, electronics at the base held the secret to this ghostly intrusion; perhaps they were playing tricks with her mind and her vision as well. Some time later, still troubled, she flew to New York to visit an ophthalmologist who specializes in cataracts caused by radiant energy. He confirmed what she feared; electromagnetic waves had left their mark just as clearly as a burglar leaves fingerprints. The tissues in her eyes were clouded in a way that, given her youth and good health, could be explained only by exposure to radiant energy. Today the woman still lives in her farmhouse; but now she has serious psychiatric problems. Her husband, filled with anxieties that his land will be devalued, urges her to keep her story to herself. She feels she has no one to turn to.

There is reason to believe her feelings of abandonment are justified, for many scientists insist that electromagnetic waves can do no such harm. The small band of researchers who would believe her tale, moreover, are in no position to help her; they say they are being shunned and isolated themselves. This scientific minority accuses industry, which sells electronic gadgets, and the military, which depends on them, of squelching the scientific publications, cutting off funding, and attacking the reputation of anyone who questions the proclamation that electromagnetic waves are safe.

The facts, indeed, seem to bear out the claims of these

researchers. Recently, the head of the department of biology at Harvard—speaking as a representative of the prestigious National Academy of Sciences—publicly lied about research and lashed out at the credibility of colleagues who differ with his benign depiction of a Navy project. Judges, too, have participated in highly questionable activities while cloaked in their official capacity as arbiters of a hearing over power lines, which also broadcast electromagnetic waves.

The controversy is a complex and many-faceted one; it is not well served by simplified conspiracy theories and personal vendettas. Part of the problem, of course, concerns the effect powerful electromagnetic waves have on the human body, which depends on its own microscopic currents of electricity to accomplish such delicate tasks as sparking heartbeats and transmitting the electronic signals we call human thought. But the issue has gone beyond these medical matters. The electromagnetic controversy now poses the larger question of human rights—not only the right to a healthy environment, but such fundamental rights as the freedom to speak, to inquire, to explore and discover.

Two years ago, Paul Brodeur examined some of these problems in his much-acclaimed book, *The Zapping of America: Microwaves, Their Deadly Risk, and the Cover-up*. Unfortunately, however, the story continues. A U.S. ambassador is now reported to be suffering from cancer after having worked in the Moscow embassy, which the Russians had beamed with microwaves; he is the third ambassador to contract the disease after serving at that post. Moreover, low frequency waves—the kind that come from power lines—have now become another fierce part of the debate. Meanwhile, our uses of electronics multiply daily. The air in this country fairly vibrates with the waves from 9 million broadcasting transmitters, 30 million CB radios, and from the telephone network. The largest newspapers transmit their copy to printers via microwaves. Not one plane could lift itself into the sky, or fly,

or land, without radar. Add to this electrified atmosphere 500,000 miles of high-voltage wires, and it is readily apparent that the modern way of life depends on what many experts call our electronic smog.

Despite the fact that the average American makes use of electromagnetic waves each day, few people really understand how they work. An electric charge sets off a ripple of electric and magnetic force in the same way that we set waves in motion when we dive into the sea. We measure these waves by their frequency—the number of times they go up and down per second—and their intensity, which is determined by the power of the initial charge. Frequency is measured in hertz; intensity, in milliwatts. *The electromagnetic spectrum* refers to waves of all frequencies, from the very highest—X-rays—down through microwaves, radiowaves, and finally extremely low frequency (ELF) waves, the kind we use for electric power. *Radiation* simply refers to the movement of these waves through space. The highest frequency waves vibrate so quickly that the material through which they pass breaks up into charged particles called ions. This phenomenon is called ionizing radiation, the kind that is associated with nuclear power, for example, and rips through cells in human tissues. Lower frequencies, like microwaves and ELF, are called non-ionizing radiation; while we do not fully understand their effects on the body, we do know that they do not destroy cells in the way ionizing radiation does. For that matter, some of the effects of microwaves are quite different from those of ELF. But that story is best told from the beginning.

IN 1947, DR. HERMAN SCHWAN, a biophysicist who for the previous decade had served as a professor at the Kaiser Wilhelm Institute of Biophysics in Germany, came to the United States to become a research scientist for the U.S. Navy. In 1950, he took a position as a professor of electrical engineering and physical medicine at the University of Pennsylvania, where he remains today, a highly funded researcher in electromagnetics. His research funds come primarily from the Department of Defense.

Shortly after his arrival at the University of Pennsylvania, Dr. Schwan set out to identify the levels of microwaves—that is, high frequency waves—that the human organism can withstand. Although he was neither a physician nor a biologist, Dr. Schwan assumed that the only effect microwaves have on living tissue is that of heat—the effect, basically, that an oven has on a ham. Using a metal ball as a model of the human body, together with his own assumptions of how much heat the body can throw off by means of perspiration and other biological processes, Schwan figured that a person can safely handle an exposure of 10 milliwatts of microwaves per square centimeter of body surface.

In 1953, Dr. Schwan proposed his 10-milliwatt standard to the Navy. The armed services, in fact, were looking for an exposure standard for their personnel just about this time, for they were dreaming of the day—they knew it would come soon—when their scientists would develop high-power radar.

During the following years, the armed forces eagerly pursued the idea of setting a personnel standard. Little actual biological experimentation was conducted, however; the few studies that were done tested only the effects of very high doses of microwaves. Solomon Michaelson, a veterinarian at the University of Rochester who is also largely funded by the DOD, tested intensities so high he induced gross burns in test animals. By virtue of these experiments, he said he confirmed Schwan's postulation that a 10-milliwatt standard would be safe. No one actually tested the 10-milliwatt level for anything other than heat.

In 1965, the Army and Air Force adopted the 10-milliwatt level. One year later, the U.S. American Standards Institute also adopted 10 milliwatts, but as an occupational guideline only. Other than a microwave-oven ruling, which limits leakage to one milliwatt at purchase and five milliwatts after use,

no standard protects the American people. (While the National Institute for Occupational Safety and Health is now considering setting a standard, some of those who have reviewed the proposal denounce it as inadequate.)

The level that we had determined as "safe" was a thousand times greater than the standard accepted by the Soviet Union. This fact was to become more significant than any of the military brass or scientists imagined; for in 1962, the State Department discovered that the American embassy in Moscow was being irradiated by a microwave beam. Clever Russians: At its high-point of 18 microwatts, the beam was almost twice as intense as their own safety standard of 10 microwatts; yet it was about 500 times less than the standard that the Department of Defense had insisted was harmless.

The State Department decided not to tell any of the embassy employees that the building was being irradiated. Instead, it conducted a secret investigation of microwaves. The study, called Project Pandora, was completed in 1970. While those involved reported that the Moscow signal had no biological effects, they destroyed the data on which they had based the study.

Dr. Milton Zaret, an ophthalmologist now practicing in Scarsdale, New York, is one of the scientists who question the Pandora report. Zaret had been asked at the time to do research on the Moscow signal for the CIA. He says the CIA told him its agents had established the fact that the Moscow signal had not been intended for listening in on embassy conversations or for jamming our surveillance equipment. Zaret was asked to review Soviet medical literature to see

Bees exposed to an electromagnetic field sealed off their hive and suffocated.

what the Russians themselves had in mind. His conclusion: "Whatever other reasons the Russians may have had, they believed the beam would modify the behavior of personnel."

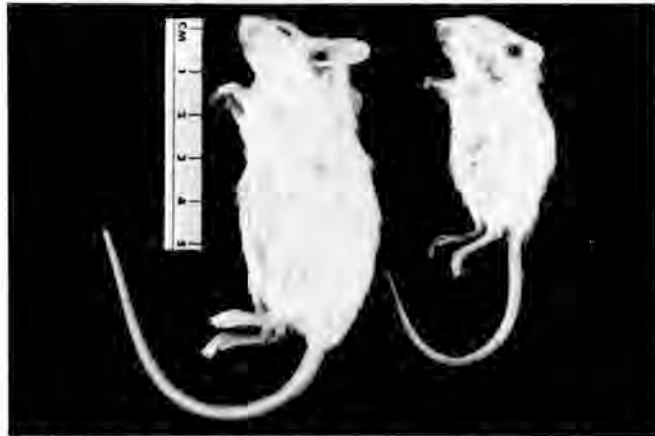
The employees in the embassy were not officially told about their irradiation until 1976, when, according to the State Department, the intensities of the beam increased. By this time, Ambassador Stoessel—whose office caught the center of the beam—was suffering from a blood disease, nausea, and bleeding in the eyes. The State Department installed metal screens on the windows of the buildings, declared the post "unhealthy," and gave employees a 20 percent raise. Nonetheless, it informed personnel that "no medical problems had been identified with low levels of microwaves." The department also insisted that the beam had been aimed at the roof, where it was meant to deactivate our electronic surveillance equipment. This explanation has yet to be accepted by engineering experts, however, who say the weakness of the beam did not suit it to that purpose.

Whatever the furtive explanations for the signal, the public outcry has been intense—particularly against the State Department for having kept information from embassy employees. Perhaps to assuage this irate reaction, the State Department contracted Johns Hopkins University to do a massive epidemiological study of some 4,000 former employees of the Moscow embassy. Dr. Abraham Lilienfeld, of Johns Hopkins, directed the research team, but the State Department itself designed the study and provided Lilienfeld with much of his information. The final report "supports the conclusion that governmental employees did not encounter health hazards traceable to their exposure."

While government officials tout this study as cause for great relief—a vindication of microwaves—Lilienfeld himself calls for caution in the interpretation of his results. He says he "would not use the word 'reassuring' to describe the report. Since the latency period of cancer can be as long as 20 years,

and since the people who had the highest doses were exposed as late as 1977, there has been little follow-up."

But the most startling piece of information Lilienfeld has to offer today concerns the health of Ambassador Stoessel. As Lilienfeld was gathering the immense amount of data for the State Department study, he was provided with one fact that has not yet been given to the American people: Stoessel now suffers from either "a lymphoma or a leukemia." Stoessel's ill health takes on a measure of significance when one recalls that two of his predecessors, Charles Bohlen and Llewellyn Thompson, have died of cancer. How do these facts square with Lilienfeld's report, which finds "no health hazards"? "It is conceivable," says the epidemiologist, "that someone in the



Mice exposed to an ELF field, Marino said, exhibited the classic signs of stress.

center of the beam who was affected more wouldn't show up in the size of our study." Stoessel, now stationed in Germany, declined to answer *Saturday Review's* questions on the matter.

The link between cancer and microwaves has also been brought up in another recent development. Last year, the chief epidemiologist for New Jersey discovered that the cancer rate in Rutherford was way above normal. Five children at the Pierrepont Elementary School had developed cancer; the odds against such a situation, one report stated, were 10 million to one. According to the FCC, some 6,400 sources of microwaves are located within a 15-mile radius of the town. The school itself is situated on top of a hill, a good target for microwaves. The citizens of Rutherford wanted microwave measurements. First, the state assigned Bell Laboratories to do the job, despite the fact that its parent company, ATT, was involved in a suit regarding a man who died from what his doctor claims were exposures to microwaves. When Bell's equipment proved faulty, a public uproar ensued; and the National Bureau of Standards remeasured microwaves in the area. A spokesman for that group has found what he calls "field strengths that are high enough to imply something. The data that we've got will make other government agencies want to look at Rutherford, too."

In the meantime, research on microwaves and their biological effects continues. The Government Accounting Office has conducted one review of the literature that cited 1,000 research papers. Among the effects reported were central nervous system disorders, genetic damage, reductions in the brain's electrical activity, loss of memory, and malformations of the fetuses of exposed animals.

Milton Zaret, the ophthalmologist who reviewed the Soviet literature for the CIA, has identified more than 50 cases of cataracts caused by nonionizing radiation. Fifteen of these were air traffic controllers and commercial airline pilots.

Dr. Allen Frey, a biophysicist at Radomline, a scientific

research organization in Pennsylvania, has demonstrated that average power densities of 0.2 milliwatts affect the blood-brain barrier, that is, the ability of the brain's blood vessels to pick and choose what materials enter this vital organ. Other researchers, using some of Frey's basic data on cardiac research, have found that microwaves measured under 10 milliwatts affect the electrical pulses that spark heartbeats and can either slow the heart down or speed it up.

The literature of the Eastern bloc countries is replete with reports of such microwave effects as headache, fatigue, and reduction in sexual capabilities. Dr. Frey, who was recently asked to lecture extensively in the Soviet Union, reports that the Soviets have elevated microwave study to a top priority, assigning the research to their best organization, the Academy of Sciences, and naming as director the same man who did extensive scientific work in their space programs.

How do those who consider microwaves harmless react to these studies? Rather underhandedly, it appears. A historian at the University of Michigan reports in one study that Raytheon, which owns the companies that manufacture radar and Amana microwave ovens, went to the government to stop one scientific investigation. Zaret reports that an army officer tried to pull one of his papers from a scientific journal that had accepted it for publication. At a trial regarding a microwave-damages suit, Solomon Michaelson, the veterinarian who helped set the 10-milliwatt standard, tried to discredit Zaret by questioning his abilities. Later testimony revealed that Michaelson's mother had been operated on by Zaret, who restored the vision of an eye that had been blind.

WHILE MOST OF THE researchers working on microwaves must battle to defend their findings, few researchers have even attempted to study the biological effects of ELF—the frequency used for high-voltage wires. The little we do know about low frequency fields—particularly about the field that naturally emanates from the earth—implies that they are intimately connected to the course of life itself. Studies of ocean sediment indicate that, with the last reversal of this field, 25,000 years ago, entire species vanished from the planet. Another indication of the importance of this field is tied to the fact that the field around the human brain has the same frequency as the field around the brain of every other living organism; and they, in turn, have frequencies comparable to the earth's natural magnetic field. Theory has it that the first living cell, formed at creation, took its electricity from the atmosphere that surrounded it. Studies show, further, that man's biological cycles depend on the rhythms of the earth's magnetic field; if a man is put in an underground bunker that is shielded from the field, these cycles go askew. Other studies indicate that the incidence of nervous and mental disease and suicides is related to magnetic storms.

We do not know what happens when we alter the earth's natural field; nonetheless, we have increasingly injected it with our own electric waves. High-voltage wires are one of the most notable sources of ELF pollution. Few people realize that electric power does not flow *through* the lines; it flows in the *direction* of the line; its fields extend for thousands of feet on each side. This can be vividly illustrated by the fact that a fluorescent bulb held under a high-voltage wire will light up by itself. Though little study has been done on the effects of these lines, one report published recently in the *American Journal of Epidemiology* found that in a large residential area the greatest numbers of children with cancer lived in homes that were located nearest to power line substations, and thus were exposed to ELF electric fields.

In 1973, the link between microwaves and ELF had not yet been perceived. It was then that Dr. Robert Becker, a distinguished researcher and orthopedic surgeon at the V.A. Hospital in Syracuse, New York, entered the story.

Becker himself had spent his career studying applications

of electricity for bone healing and growth. Because of his pioneering research, Becker was asked by the Navy to sit on the Ad Hoc Committee for the Review of Biomedical and Ecological Effects of ELF Radiation.

The Navy's interest in ELF was specifically attached to a \$100 million antenna it hoped to build. Called Project Sanguine, the antenna would allow the Navy to communicate with deep, fast-running submarines. It was to be a grid of buried wires covering 25,600 square miles of northern Wisconsin. Though it would broadcast at a frequency near 60 hertz, the electric-line frequency, its signal would be 1 million times weaker than that of a power line.

The ad hoc committee decided that Sanguine's effects would be different from what its name implies. After reviewing many studies—some of them on humans—it called for an "urgent and absolutely necessary" continuation of a study that had indicated Sanguine would affect the levels of triglycerides in the human bloodstream, a warning, researchers say, of stroke. "Strong emphasis" should be given, it said, to studies of Sanguine's effects on the central nervous system. The report also called for further psychological testing and studies of human biorhythms. The committee of researchers unanimously recommended that the federal government be "apprised of the possible significance to the large population at risk in the United States who are exposed to 60 hertz fields from power lines." Though the report was unclassified, the Navy did not release it. None of the recommended studies was conducted. The project was renamed Seafarer, a change one official ascribes to bad publicity.

Soon after the meeting, Becker discovered that two utilities were planning to build a 765-kilovolt high-voltage line in upstate New York. With the recommendations of the committee still ringing in his ears, and the knowledge that a high-voltage wire is 1 million times as powerful as Sanguine was intended to be, Becker immediately wrote the head of New York's Public Service Commission, briefing the official on the ad hoc committee and its conclusions. Becker, along with Andrew Marino, a biophysicist in Becker's labs, was then asked by the PSC to testify at hearings regarding the line.

During the first set of hearings, the two reviewed the literature regarding ELF. They said that an ELF field near the head of a human had induced anesthesia. It had affected the chemical balance in the blood, brain, and liver of rats and had slowed the heartbeats of exposed salmon and eels. It had interfered with the ability of homing pigeons to find their way. It had caused bone tumors in mice. Bees exposed to an ELF field ceased to store honey and pollen and began to kill one another; in a few days they had either abandoned or sealed off their hives, causing their death by asphyxiation.

On hearing such evidence, the two power companies, Niagara Mohawk and Rochester Gas and Electric, asked that the hearings be postponed for a year.

In the intervening months, Dr. Marino conducted two of his own experiments. In one study, rats exposed to an ELF field failed to gain weight normally. In another, three successive generations of mice exposed to ELF fields were stunted. Marino concluded that the animals were exhibiting the classic signs of stress.

Becker and Marino returned to the hearings a year later confidently carrying the data from their experiments. Who should they see, then, as witnesses for the utilities? Herman Schwan and Solomon Michaelson, the DOD-funded microwave researchers, together with a botanist from the University of Rochester named Mort Miller.

As Marino described the ensuing scene, "they came down on us like a ton of bricks." Schwan had made calculations, once again using a metal ball as his model for the human body, and had concluded that ELF fields could not affect biological processes. With the Miller-Michaelson-Schwan trio to prompt the utility lawyers, the cross-examination of Marino and Becker went on for 17 days.

In the meantime, Senator Gaylord Nelson of Wisconsin had discovered the ad hoc report and was, according to an aide, "hopping mad." Nelson issued a press release stating that the Navy had apparently "kept the wraps on the existence of this report because it contains the very first scientific evidence that Sanguine would have an adverse environmental impact."

Due to Nelson's ire another Sanguine/Seafarer study was to be held; this time, it would be conducted by the National Academy of Sciences and chaired by Professor Woodland Hastings, the head of the department of biology at Harvard.

Professor Hastings wrote to Andrew Marino saying he had been told of Marino's "research contributions concerning the biological effects of low frequency radiation." As chairman of



A fluorescent bulb will light when held under a high-voltage wire.

the new NAS committee, Hastings wrote, he "would be pleased to have consultation" with Marino.

Marino telephoned Hastings and asked who else was to be on the new committee. The Navy had chosen nearly all members, Hastings replied. The members included Herman Schwan, Solomon Michaelson, and Mort Miller.

Marino told the professor about the PSC hearings currently being held in New York State. Power lines, he said, were 1 million times more powerful than Sanguine/Seafarer; three men who had been paid by a utility to testify that the lines were safe were hardly likely to perjure themselves, or jeopardize their interests, by finding a much weaker field to be dangerous. According to Marino, Hastings said he would quit unless the three men were removed from the group. He promised to put Becker and Marino on the committee.

Later, Marino called Hastings back. As Marino tells it, the professor said that all three men had filled out NAS "bias statements" to reveal possible vested interests; none had indicated that they were engaged in the New York hearings. To a question that asked whether or not the committee member owned stock in power companies and if so, whether the holdings totaled more than or less than \$10,000, Mort Miller had checked "more." His stock holdings were in Niagara Mohawk, the company on whose behalf he had testified.

The first committee meeting was held, but Becker and Marino had heard nothing from Hastings about their own membership. They sent a letter to the National Academy, detailing the entire tawdry incident. The letter was reported in *Science*, the official journal of the academy.

A small tempest ensued in the august body; Schwan and Miller both wrote angry retaliations. But it was chairman Hastings of Harvard who made the most puzzling comment on the matter. He called the charges "ridiculous."

Today, two years after his committee has given Seafarer "a clean bill of health," Hastings insists that testifying for a

utility "is not a basis for removing anyone from eligibility."

Hastings went on to tell *Saturday Review* that Marino and Becker have not even done work in ELF—forgetting, perhaps, his letter asking Marino to sit on his committee, as well as Becker's involvement with the ad hoc group. But the information Hastings volunteered about the hearings on utility lines was the most remarkable of his statements:

"The judge threw out the case with prejudice—ruled that Marino's not a believable witness, that he's evasive and deceitful. Here we were being attacked by people who ultimately were thrown out of a court of justice in that way. They've all been thrown out. These guys are all a bunch of quacks."

Given the fact that three of his committee members were engaged in the hearing, it seems difficult to believe that Hastings does not know that the Public Service Commission not only defended Andrew Marino's credibility in its final decision; it also ruled that the utilities had to purchase a large strip of land running under their power lines in order to keep people away from the electric field. Furthermore, it ordered that the utilities put part of their profits in a fund that would be used to support research on the biological effects of ELF.

But a double checking of that decision led to the discovery of yet another ignominious act.

In a PSC hearing, the first step is a recommended decision by the judges who are present at the hearings. The PSC itself then reviews the record and issues a final judgment.

While the final judgment did indeed support Andrew Marino, the recommended decision was startlingly antagonistic to him. Though 31 experts had testified at the hearing, almost

Honesty and morality are as essential to American science as genius.

one-third of the recommended decision—49 pages of 156—was devoted exclusively to Andrew Marino, his single rat experiment, and his credibility. His work was termed "reckless, inaccurate, careless, and unsupported." He was called "evasive and argumentative." Incredibly, Judges Thomas Matias and Harold Colbeth admitted the NAS committee report into the record to show that the "distinguished, nationally known scientists" who had developed the report "disagree with the essential opinions and conclusions advanced by Dr. Marino in this hearing"—this, despite the fact that three of these "distinguished scientists" were paid to testify for the utilities in this very hearing!

What on earth was going on here? Judge Colbeth's files contained the answers. Through the Freedom of Information Act, Marino obtained correspondence between Judge Colbeth and Asher Sheppard, a researcher who at the time worked at the Brain Research Institute at UCLA. Sheppard had received \$5,250 to "furnish assistance in evaluating conflicting testimony of biophysicists." Judge Colbeth had directed Sheppard to "discuss his conclusions as to which positions are the more persuasive. We hope to put your report bodily into our decision with a few language changes for consistency of style."

This arrangement, in and of itself, is not illegal; many judges request and receive expert advice. The agreement would become questionable if the decision Sheppard wrote contained new information—it is a violation of due process to base a judgment on material not presented in a hearing—or if Asher Sheppard had reasons for being biased.

As for the possibility that Asher Sheppard was biased: The outcome of the hearing, obviously, is vital to all utilities. Asher Sheppard was once employed by Con Edison. At the same time that he was preparing the decision, moreover, he was writing a report for the American Electric Power Company, entitled "The Biological Effects of Electric and Magnetic Fields of Extremely Low Frequency." Sheppard left one

more track of footprints across his report. His boss at UCLA was Dr. Ross Adey, who discovered that ELF fields increase the flow of calcium from the brain, possibly affecting the cortex. Adey's work was heatedly criticized during the hearings. Not a word of that criticism landed in the recommended decision, an imbalance, to say the least, compared to the 49 pages of criticisms of Andrew Marino.

Though the hearing is over now, the testimony delivered has recently resulted in two significant developments.

The Department of Energy is now paying \$1.5 million for another rat study (Marino conducted the original experiment at the cost of \$3,000). The head of the division of DOE that oversees studies on ELF, Robert Flugam, has stated publicly that he already believes power lines to be safe. He has also commented that until experimental data can be obtained to disprove the rat study, the course of action to be taken is to discredit Marino. But Flugam, of course, is not the only person who sits on the peer review board that oversees the rat study. Also on the board are Sol Michaelson and several utility executives, including one from Niagara Mohawk.

The controversy surrounding the rat experiment has also elicited what is undoubtedly the most significant development in the ELF debate. During the course of the hearing, Sol Michaelson severely criticized Becker and Marino for saying that the rats exhibited signs of stress. Michaelson contended that the rats showed no such debilitation; and even if they did, he added, stress can be good for you.

But the great doctor-philosopher Hans Selye has something interesting to add to these comments. Selye himself first described the biophysical effects of stress, showing that the condition elicits certain measurable hormonal responses in man. Selye told *SR* that both microwaves at nonthermal levels and ELF fields from power lines can cause stress. He also stated that the contention that such stress is good is "far-fetched. While I have shown that stress is good for many people, I would not say that applies to electromagnetic stress."

The fact that Selye would take such a stand is essential to this tale; his unassailable credentials cannot be questioned or discredited. Selye, however, went a step further: He said that the real experts on ELF were in the United States, and that their research was the work to be depended upon. He sent a sampling of 18 such reports from his library; among them were two written by Becker and Marino.

Even the remarks of a scientist as respected as Hans Selye, however, fail to provide the layman with a magic solution to the electromagnetic dilemma. The average American hasn't the background to determine the effects of electric waves. Moreover, even the most concerned environmentalists would never suggest that radar and power lines be disassembled; they are vital threads in the fabric of American life.

There are a few conclusions, however, that the layman is qualified and indeed justified in accepting. The first is that metal balls and calculations cannot determine what is or is not a dangerous assault on internal organs; the secret splendors of the human body do not reveal themselves on graph paper. Nor will we discover much with experiments designed to give us pre-planned, fabricated results.

But perhaps the most important conclusion for the layman is that honesty and morality are as essential to American science as genius. "The threat to intellectual freedom is a threat to the independence and worth of the human personality, a threat to the meaning of human life," writes Soviet physicist and dissident Andrei Sakharov. "It is essential that we not restrict our research to that done in a government controlled program; otherwise we might be tempted to avoid 'unpleasant' subjects and questions."

Perhaps the time has come to question a government that endangers its people in the name of defending them; an industry that pursues the quality of life at the expense of public health; and those scientists whose technological wonders today may threaten nature's own wonders tomorrow. ●