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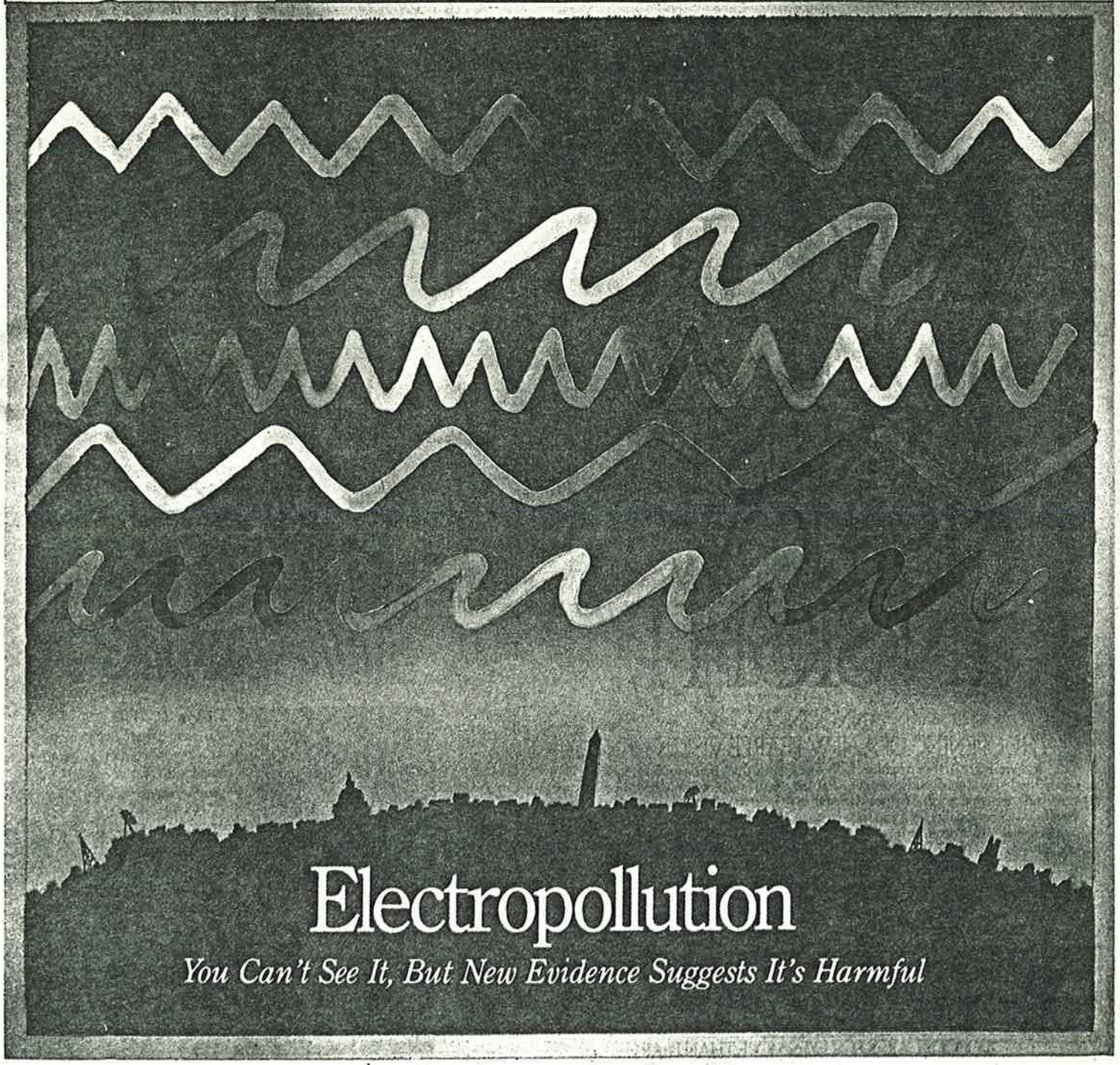


Electropollution

You Can't See It, But New Evidence Suggests It's Harmful

"If the cost of compliance exceeds $7 million per life saved, then you don't do it," explained one EPA official. "We're talking about $40 million for the whole [broadcast] industry. That's on the order of about five lives."

electric fields—about the same frequency of nonionizing radiation as would be found in a leaking microwave oven. In another experiment human white blood cells manufactured lower levels of an important enzyme known as protein kinase after bombardment with microwaves. How this affects the white blood cells' ability to fight disease isn't known yet.

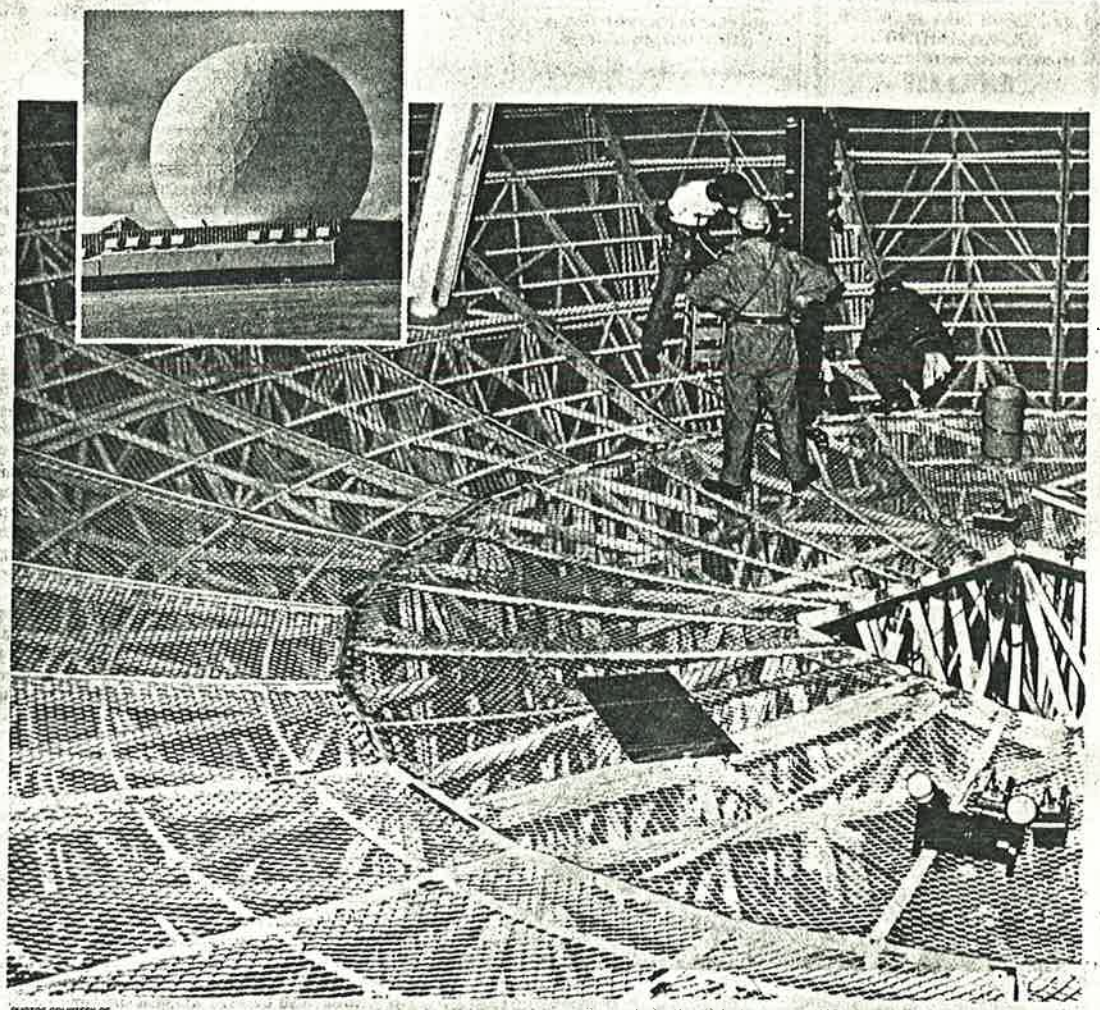
■ Chicken embryos placed in pulsed, very-low-frequency electromagnetic fields showed severe brain developmental damage at certain electric frequencies, report Dr. Jose M.R. Delgado, director of the research department of Madrid's Centro Ramon y Cajal, and his colleagues. At other frequencies the embryos were unaffected.

■ At the Midwest Research Institute in Kansas City, Mo., male volunteers between 21 and 35 were paid to sit in a room of nonionizing radiation as part of an experiment cosponsored by the Department of Energy and the New York State Department of Health. A matched control group sat in the same room without being bombarded with nonionizing radiation. Neither the men nor the researchers knew who was being exposed to the electric fields. Test results showed that exposure to the field slowed the heart rate about three beats per minute and altered brain wave patterns recorded on electroencephalograms (EEGs).

■ Two separate animal studies also have shown that heart rates can be altered by exposure to electromagnetic fields. In one study, by biologist Allen Frey at Randomline Inc. in Huntingdon Valley, Pa., frog hearts isolated in a laboratory were stopped with nonionizing radiation. In another, University of Utah researcher John Lords was able to speed up and slow down turtle hearts by exposing them to varying levels of microwaves.

■ Several studies show that nonionizing radiation can alter the blood-brain barrier—an important protective shield that excludes harmful substances from the brain.

■ Insulin-producing cells from the pancreas reduce their production when exposed to low levels of nonionizing radiation, according to research by Dr. Weldon Jolley of the Veteran's Administration Hospital in Loma Linda, Calif. Other studies show that electromagnetic fields can change the circadian rhythms—the internal clocks—of humans and birds. Numerous other research by Dr. Adey and his colleagues has also revealed that electromagnetic fields can alter the subjective sense of time in monkeys, lower body temperatures in rats and increase the release of carbon dioxide in cats.



PHOTOS COURTESY OF THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

Interior and exterior views of the Clear Air Force Base radar dish in Alaska, where six workers were exposed to microwave radiation in 1983. The first sign of trouble came when two of the workers' flashlights emitted light even though they were turned off. The radar dish measures 84 feet across.

Despite the mounting evidence that nonionizing radiation causes biological changes, many people find it difficult to understand how something that eludes normal senses can cause harm—particularly since the physiological effects of exposure typically go undetected. One explanation is that pain and burn sensors are located near the surface of the skin, so they are often unaffected by the deep-penetrating nonionizing radiation and do not signal the brain that the body is being harmed. Bones and fat deposits also affect how much energy is absorbed internally. "You can get burns around the bones without doing much to the surface [skin]," explains Food and Drug Administration biophysicist Zory Glaser.

Although scientific evidence of health hazards is growing, no enforceable standards for accept-

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Bombarded in a Radar Dish

On Sept. 14, 1983, six workers climbed up into an 84-foot tracking radar dish at Clear Air Force Base in Alaska to begin routine repairs on part of the nation's Ballistic Missile Early Warning System. By the time they climbed down a few hours later, they had become unwitting participants in the debate about the health effects of nonionizing radiation.

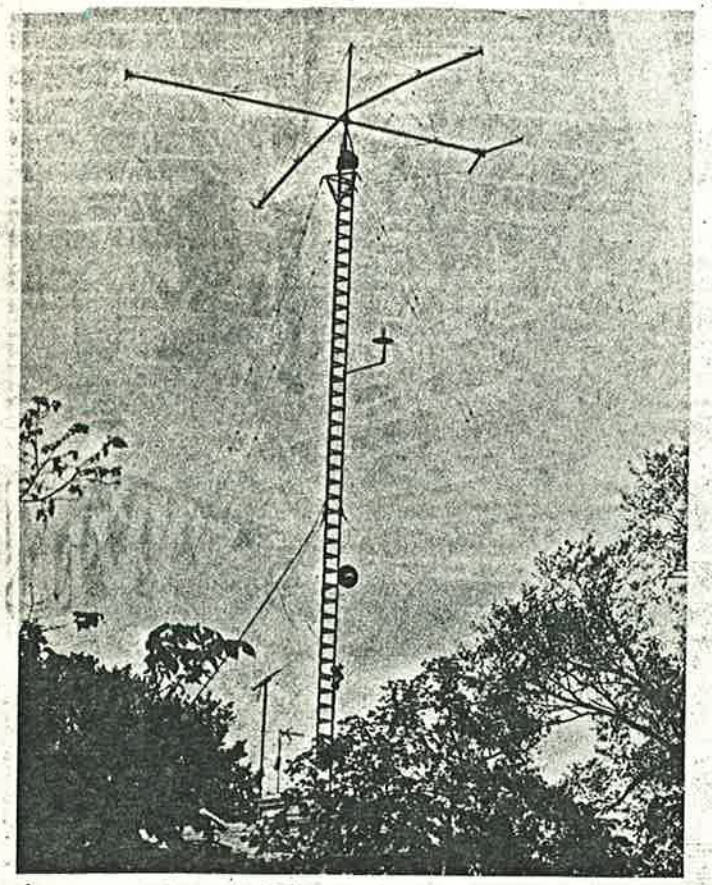
A flashlight gave the first warning. Although it was turned off, it "neoned"—emitted a flash of light—according to the accident report submitted by FELEC Services, a subsidiary of ITT, which is contracted to service the facility. A second pocket flashlight did the same thing. The six men suddenly realized that the radar dish was on and acting like a giant microwave oven. They were literally being cooked.

Exactly how long the radar operated and at what power is still under debate. The men (two civilian Air Force workers and four employes of FELEC) say that they were exposed for about 17 minutes. The Air Force and FELEC think the exposure lasted for eight minutes. Whatever the length of time, two men were hospitalized immediately after the accident for nausea, dizziness, headaches, extreme fatigue and memory loss. Several men involved in the accident have since traveled to New York, Boston and San Antonio seeking further medical treatment for continuing headaches and other symptoms. They've also requested help from Dr. Ross Adey, an expert on nonionizing radiation at the Loma Linda Veteran's Administration Hospital in California.

The Air Force disputes the men's health complaints, and the debate will probably be decided in court. Several of the workers have engaged Oklahoma City attorney John Running to represent them. Running declined to comment on the case.

The accident illlustrates two things, says Rep. Don Young (R-Alaska): The importance of proper safety procedures at microwave radar facilities and the need for obtaining prompt medical treatment for victims of overexposure to microwaves. "These workers wanted appropriate medical treatment," Young said, "but the system was not in place, they were not properly treated on time."

— Sally Squires



BY ELLSWORTH DAVIS—THE WASHINGTON POST

This antenna, at the Turkish embassy on 23rd Street, is the same model that the People's Republic of Benin wants to install on the grounds of its embassy on Cathedral Avenue. Woodley Park residents fear for their health and their television reception.

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able exposure levels to nonionizing radiation exist today in the United States. The Soviet Union and other Eastern Bloc countries set fairly stringent standards for exposure to nonionizing radiation—although there is some evidence that these standards are not strictly enforced. In this country, the Occupational Safety and Health Administration, which regulates exposure at the worksite, is hampered by a legal loophole that makes its standard a "suggested guideline" rather than a mandatory regulation.

Last year, after five years of research, the Environmental Protection Agency attempted to publish proposed recommendations for broadcast frequencies, which are responsible for 90 percent of the nonionizing radiation to which Americans are exposed. These recommendations would have been the first step toward setting standards for nonionizing radiation exposure to the general population. But the day before those guidelines were to appear in the Federal Register, they were dropped based on the results of a high-level, internal agency review.

According to sources at EPA and other agencies who requested anonymity, the review found that "there is no problem from nonionizing radiation. No one is dying, no one is being harmed to our knowledge. EPA does not regulate in this administration unless it is absolutely necessary."

"In other words, if the cost of compliance exceeds $7 million per life saved, then you don't do it," explained an EPA official who asked not to be named. "To implement standards of the original EPA proposal, we're talking about $40 million for the whole [broadcast] industry. That's on the order of about five lives."

While some are pushing for enforceable standards now, others—like Dr. Robert Becker, a retired researcher from Syracuse University and a pioneer in using the electromagnetic effects on bone healing—say it's too soon. Becker and others would prefer to see more extensive research to ensure that the most stringent standards are set.

"There is no way that we can give a clean bill of health to anything at the present time," says Becker.

"We definitely think that there is a need for further study," agrees Dr. Katherine P. Farrell, chief of the Division of Environmental Disease Control, which conducted the Maryland State study of brain tumor deaths. "Much of this data is very rough. We don't really know how long people have had exposure or to what levels."

But the prospect for new research isn't good. Maryland researchers are searching for money to follow up their findings. Funding for studies on nonionizing radiation is being cut drastically by the Department of Defense, one of the major backers of investigation. The EPA's nonionizing radiation group at the Health Effects Researchers Laboratory in Research Triangle Park, N.C., will be dissolved beginning in October. The budget for the Department of Energy's Electric Energy Systems Division, which studies the health effects of power lines, will be cut in half beginning in October.

This is particularly disturbing to those who believe that science is close to understanding the health effects of nonionizing radiation. Not only could these studies be "important in controlling the potential hazards of electromagnetic field exposure," Adey says, but they also could provide important new clues in basic biological and medical research. "We're starting to tune in," he says, "on the music of cells."

This information could help solve such elusive mysteries as aging and uncover the way cells send messages to each other—as they seem to do—with no apparent route of physical contact or chemical message. And the field is offering a new look at cancer, Adey says, speculating that perhaps we will come to understand "the difference in the pattern of signals passing through the cells as it becomes cancerous."

One line of investigation suggests that electromagnetic fields may act as a cancer promoter—that is, they may make work in combination with other forces in the environment to promote cancer. "There needs to be something to push the button to make a cell go cancerous," says Adey. "It could be many things, including nonionizing radiation." ■

Antenna Battle in Woodley Park

When officials from the People's Republic of Benin applied for a special zoning exception to build a radio tower in the District last December, their proposal sparked a furor.

The 38-foot radio tower, which would beam messages to Benin, a small country in west Africa, is now at the center of a fierce community battle.

Benin and the State Department are on one side. On the other side is the 6,000-member Woodley Park Community Association, which vehemently opposes construction of the radio tower in the chancery's back yard at 2737 Cathedral Ave. NW.

Woodley Park is a small neighborhood nestled on the Connecticut Avenue corridor just north of Calvert Street. Residents oppose the tower primarily because of concern over possible health hazards from tranmissions. There is also fear that the embassy's radio signals would wreak havoc with radio, television and telephone transmissions.

By one engineer's estimate, both are real possibilities. The antenna and tower are to be just 40 feet from a residential property line. The diamond-shaped antenna is about 44 feet across and is to operate at varying frequencies of seven to 24 megahertz, which could mean that exposure to nonionizing radiation levels may exceed standards set by the American National Standards Institute.

Benin and the State Department argue that the radio tower will be safe and won't interfere with the neighborhood's communications.

The issue has become politically awkward since the government of Benin has already allowed the United States to construct similar radio towers in that country.

Both sides brought witnesses to the District's Board of Zoning Adjustment last week to argue their cases. The outcome could be decided by the board as early as today.

— Sally Squires

Electropollution Glossary

Electropollution has a language all its own. Among some of the commonly used terms are:

Atom. The smallest component of an element that has all its properties and can exist alone.

Current. A flow of electrically charged particles.

Electromagnetic field. Currents create magnetic fields around themselves. If the current flows backwards and forwards far enough and for a long enough distance, then electromagnetic energy will move away at the speed of light.

Electron. A subatomic particle with a negative charge. Electrons usually orbit around atoms and are attracted by protons—subatomic particles that carry positive charges.

Frequencies. The number of times an electromagnetic field changes direction per second, per minute or per other unit of time.

Hertz. A unit of frequency measuring cycles of electricity per second. One hertz is like one complete wave in the ocean.

Ions. Atoms that have negative or positive charges because they have unequal number of electrons and protons.

Ionizing radiation. Electromagnetic energy that generates ions by knocking electrons from the orbit of atoms. Includes cosmic rays, gamma rays and X-rays, all of which have a very high frequency.

Nonionizing radiation. Electromagnetic fields that oscillate at a slow rate and are unable to knock electrons from the orbit of atoms. Nonionizing radiation includes visible light waves, infrared, television signals, radio waves, short waves, extremely-low-frequency (ELF) waves and even ordinary household alternating current (AC).

Radiation. Energy emitted as particles or waves.

Watt. A unit of electrical power.

Volts. An expression of how hard electrons are pushed through a wire; a measure of electricity's pressure.

— Sally Squires

Electropollution

New Evidence Suggests That Rays Once Thought Harmless Are a Threat

By Sally Squires
Washington Post Staff Writer

In Maryland, researchers found that people whose jobs exposed them to electricity had a significantly higher chance of dying of brain tumors.

In Kansas, young men's heart rates decreased slightly and their brain waves changed significantly after being exposed to the kind of electric fields generated by power lines.

In Sweden, military radar maintenance workers experienced brain damage and a strange protein appeared in their spinal fluid after years of on-the-job exposure to high levels of microwaves.

In Spain, chicken embryos exposed briefly to pulsed electromagnetic fields—similar to those produced by video display terminals—had undeveloped nervous systems and hearts that never formed properly.

Throughout the world, scientific research is challenging the notion that electromagnetic fields—generated by everything from household appliances to overhead power lines—are benign. Colorless, odorless and invisible, this "electropollution" is increasingly being linked with adverse health effects.

Scientists call it nonionizing radiation. Most people, if they think of it at all, know it as radio, television and radar signals. It's what illuminates lights and enables a stranded motorist call for help over a citizens' band radio. It's nuclear magnetic resonance, one of the newest diagnostic tools in medicine, and it's the giant radar dishes that are such an important part of the nation's early warning defense system.

For years, researchers have known that nonionizing radiation could be harmful if it were powerful enough to heat tissues and cells. Microwave ovens exploit this principle by penetrating food with electromagnetic waves to cook it uniformly and quickly. But scientists thought that if levels of nonionizing radiation remained low—below the thermal threshold that literally starts to cook cells—there would be no biological effects.

Now, however, more than 15 years of research is countering that notion and raising questions about the potential health effects of exposure. Science is on the threshold of finally understanding how nonionizing radiation affects the body, in part through discoveries in a new field one researcher calls "quantum biology," which applies the laws of physics to the disciplines of biology and medicine.

Among recent findings:

■ A study of 951 men who died of brain tumors between 1969 and 1982 revealed "a disproportionate representation of workers employed in occupations associated with electricity or electromagnetic fields." Included in this group were electricians, electronics engineers and utility company servicemen, reported the Maryland Department of Health and Mental Hygiene. Men with definite electromagnetic (EM) exposure also "died [of brain tumors] at significantly younger ages than those with no EM exposure." The average age of death for men in the exposed group was 53 years, compared with 58 years without exposure. Almost half of the men in the exposed group died before age 50.

About 50 men in the study who died of two types of brain tumors—gliomas and astrocytomas—were electricians, electronics engineers and electric utility or telephone service repairmen. Based on extrapolations from U.S. census data, only 18 people with these occupations should have been in the group. When researchers looked at deaths from unspecified types of brain tumors, they found 28 had been employed in jobs with EM exposure. The expected number is 15.

"These findings suggest that electromagnetic exposure may be associated with the pathogenesis [development] of brain tumors," report Dr. Ruey Lin and his coauthors in their study, which is to be published later this year in the Journal of Occupational Medicine.

■ Nonionizing radiation seems to alter the release of calcium ions in the brain and other tissues, including bone and pancreas. Calcium is crucial for many cellular reactions both in the brain and in other parts of the body. Dr. Ross Adey, associate chief of staff for research and development at the Veterans' Administration Hospital in Loma Linda, Calif., and a leader in nonionizing radiation research, has shown that these calcium changes don't occur across the board, but take place at distinct frequencies, which Adey calls "windows."

At one frequency, calcium may flow from the cells. At a slightly higher frequency, it may be unaffected, and then at an even greater frequency, the release of calcium may be turned on again, but this time at just a trickle. Why these windows occur is still unknown, but there is evidence that their existence varies based on frequency, time, intensity and type of cell. "The cell membrane must be a tremendous amplifier of the things going on around it," he says. "A little nudge at one place alters calcium binding of a few ions like a domino effect."

White blood cells, part of the body's immune system, also can be affected by electromagnetic fields, Adey and his colleague Dr. Daniel Lyle discovered. Mouse white blood cells targeted to kill human lymphoma cells were less able to do their job when they were exposed to 60-hertz

Rainbow of Radiation

One of the ways to understand the spectrum of electromagnetic energy that produces nonionizing radiation is to think of a rainbow. At the far right is ionizing radiation. As you begin to move from right to left, you pass through a spectrum that includes cosmic rays, gamma rays, X-rays and some ultraviolet light. All these forms of ionizing radiation are high energy. They earn their name because they are strong enough to knock small, negatively charged subatomic particles known as electrons from the orbit of atoms. When these electrons are knocked off, normal atoms become charged, which makes them able to disrupt other molecules.

Nonionizing radiation—which begins at about the top of rainbow—is unable to knock electrons from their tightly held orbits. The spectrum of nonionizing radiation starts at the edge of the ultraviolet band, continues through visible light and also includes infrared light and the microwaves used in radar and ovens. Then there are the ultra-high-frequency (UHF) and very-high-frequency (VHF) bands used for television. Next come the FM radio waves, followed by short wave, AM radio waves and extremely-low-frequency (ELF) signals used for submarine communication. Finally there are the alternating electric currents that bring electricity to homes and offices.

Except for infrared rays, all these forms of nonionizing radiation "readily penetrate the body," says Dr. Ruey Lin of the Maryland Department of Health and Mental Hygiene. However, how much of this radiation is absorbed "varies depending on frequency of waves and type of tissue. Systems of the body which are particularly vulnerable to electromagnetic waves include the central nervous system, the blood and immune system and the cardiovascular and endocrine systems."

— Sally Squires

The electromagnetic spectrum can be represented as a rainbow. The cutoff between ionizing radiation, to the right, and nonionizing radiation, to the left, occurs somewhere in the ultraviolet band. Colors used here represent categories of radiation and not the colors of the rays.

BY KATHY JUNGJOHANN—THE WASHINGTON POST