

WEA 1/4PMS

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SINCE THE EARLY 1970s, the United States has attempted to counter burgeoning Soviet military power by using high-technology "force multipliers." Chief among them is the command, control and communications system known as C

-- a complex network of advanced-technology radios, datalinks, radars and computers designed to gather and process huge amounts of information, thus enabling commanders to put the right forces in the right place at the right time.

Virtually all the components of this system are dependent on tiny integrated-circuit devices imbedded in silicon chips. They are the brains of such "smart" weapons as the Hellfire anti-tank missile, the AMRAAM anti-aircraft missile and the Harpoon anti-ship missile; of our communications and surveillance satellites; of the warheads in ballistic missiles; of the reconnaissance systems in AWACS aircraft.

If a device could be built that could render those chips inoperable, then everything from C

systems to the electronically gearshifted transmission of the M1 tank would be turned into junk, just as surely as man would die if his brain were destroyed.

In fact, such devices -- called radio-frequency weapons -- may already be near deployment. The Department of Defense, in its 1987 report titled "Soviet Military Power," acknowledges the situation:

"Recent Soviet developments in the generation of radio-frequency (RF) energy have potential applications for a fundamentally new type of weapon system that would degrade electronics or be used in an anti-personnel role. The Soviets already have or are working on much of the technology needed for such a system. In their research the Soviets have generated single pulses exceeding 1 billion watts, and repetitive pulses of over 100 million watts. If they choose to develop such a system, no significant technological obstacles stand in the way of a prototype short-range weapon."

Translation: RF weapons can blow out computers, radios and anything else using microchips -- leaving the weapon, vehicle or device useless. The principle is simple: Radio waves are a form of electromagnetic radiation. And when a magnetic field moves across a conductor, it generates an electrical current (which is how, for example, the alternator in your car makes electricity). If the field is strong enough and the conductor small enough -- such as the micro-fine circuit traces in a computer chip -- the resulting current will destroy the conductor. If humans happen to get in the way, the peak pulse power from RF beams can "devitalize" -- that is, scramble -- every living cell they pass through. At close range they can cause death; at greater range, the beams can create behavioral effects best described as "instant bedlam."

EMP and the Soft Kill

One type of RF weapon is a device which can repeatedly send out a huge bolt of very high energy radio waves called an electromagnetic pulse (EMP).

It has long been assumed that the EMP from a nuclear blast would disrupt electronic devices of all kinds at distances far beyond the blast. But new technology now makes it possible to generate extremely short, very high-powered pulses

without a nuclear blast. Such EMP devices, known as "soft kill" weapons, could be used as "chip guns" directed at tanks, planes, missiles, even satellites.

Robert Bass, a research mathematician who explored various Strategic Defense Initiative technologies while working for Litton Industries, feels that the United States is facing what might be called a Zap Gap in pulse technology: "We are behind the Soviet Union in directed-energy weapons based on 60-gigahertz millimeter wave beams. It is a known fact that the Soviets are developing tactical and strategic weapons based on 60-gigahertz millimeter wave beams." (That is, waves with a frequency of 60 billion cycles per second and a wavelength around one millimeter; by comparison, an average VHF TV signal is around 150 MHz -- standing for millions of cycles per second -- with a wavelength of about five meters.) All electromagnetic waves travel at the speed of light. "Such millimeter-wave weapons," Bass says, "not only have the zero-time-of-flight characteristics of lasers, but at certain specific frequencies, the atmosphere is quite transparent to them."

James Fraser, who spent 10 years researching the biological effects of electromagnetic radiation for the Air Force, says that such weapons would be comparatively easy to construct: "You could build an RF weapon like a phased-array radar. Instead of having the whole antenna move as with a normal radar, a phased array has hundreds of small dipole antennas. A computer then electronically shifts the beam in the desired direction."

"If you vastly increased the power behind each of those dipoles," says Fraser, "say with a large-scale gyrotron {see box}, you would have a weapon of enormous power whose use would only be limited by the imagination."

According to aerospace experts, the result would be military havoc. For example, the F16 jet fighter cannot actually be "flown" by human control. It is inherently aerodynamically unstable (which paradoxically contributes to its fantastic maneuverability). Instead, a "fly-by-wire" system of electronic sensors and computers keeps the aircraft stable; there are no mechanical backups. A pulse from an RF weapon could send false voltage readings from sensors or simply blow out the computers' chips, and the F16 would snap out of control with no hope of recovery.

The crucial ingredient in such a weapon is a means of vastly amplifying and carefully directing the RF pulse. "The Soviets have developed a device we call a gyrotron," Bass says. "For producing high-energy millimeter waves in the 100 gigahertz range, they are extremely efficient."

As for the Zap Gap, the senior physicist at Varian Associates, a California company that builds gyrotrons for fusion research, explains: "In the late '70s we thought we had invented something really unique with our small {about seven feet long} prototype gyrotrons. We were really surprised when we learned that the Soviets had developed much bigger ones for weapons."

Brain Guns, Heart Stoppers

High powered RF weapons derived from chip guns also could be used as tactical weapons against troops. Such RF devices could kill at ranges of at least one kilometer (slightly more than half a mile), by instantly devitalizing -- that is,

scrambling -- all the cells in the human brain stem.

"At those power densities," Fraser says, "a beam hitting the anterior spinal cord and medulla oblongata would only have to cause heating to about two grams of living matter to cause instant death."

Still worse, the EMP from such a weapon device could alter human mind function at longer ranges against advancing troops, fighter pilots, artillerymen or any military force.

In his book, "The Body Electric," Dr. Robert Becker, a physician twice nominated for the Nobel prize for his work in the bioeffects of electromagnetic fields, devotes a chapter to the vulnerability of humans to RF weapons: "The whole point is that it is now very clear that there are interactions between electromagnetic radiation and human physiology and behavior; electromagnetism is extremely important to basic operation of the human body," and "obviously intimate knowledge of those processes could be used to make extremely lethal weapons."

Speaking from his upstate New York home, Becker explained further: "A high-peak power pulse from an RF weapon, let's say one million watts for one tenth of a millisecond, is enough to override the dielectric capacity of nerve and brain cells." (Nerve cells function somewhat like a battery, holding positive charges in one area and negative charges in another by virtue of the cell membrane's polarization. When a cell is ready to "fire" normally, the membrane chemistry alters slightly, allowing a small current to flow. An RF blast, however, generates so much current that the dielectric {non-conducting} properties are destroyed.)

"With a direct hit by an RF bolt," Becker says, "the brain shuts down. There is total neural disorientation. Cardiac and respiratory control functions cease."

"A near-miss by a powerful RF bolt can manifest itself as a heat pulse that penetrates the central nervous system. Inside the brain, a violent thermo-elastic expansion and contraction will produce neural disturbances, a sensation of light flashes, loud noises and total disorientation."

Wave of the Future?

An American biophysicist who was studying at the University of Prague in 1979 recalls that, "just prior to my arrival an East German graduate student was accidentally killed while working on a project using a superconducting waveguide {a supercooled metal conduit designed to aim radio waves precisely}. The grad student was apparently oblivious to the huge magnetic field," and "a spurious event, perhaps a heat pulse through the liquid helium, or radio-frequency noise, caused the instantaneous collapse of the magnetic field. The result was an EMP with a tremendously high peak pulse power," and the student, "standing in front of the waveguide, was instantaneously killed."

Shortly thereafter, the biophysicist says, "the Soviets had the entire wall of the physics lab ripped out and all the cryo equipment, waveguides and other gear shipped to a castle at Kosice, near the Czech-Soviet border. I learned from other professors who helped with the project that after a few months the Soviet scientists were able to kill goats at ranges

beyond one kilometer, and cause disorienting or incapacitating effects, depending on the aspect angle of the goats' heads, at well over two kilometers."

Many scientists, including Fraser and Becker, believe that such technology is well within the realm of off-the-shelf reality and could be made into a truck-sized tactical system within a year.

While Fraser was working on electromagnetic research for the Air Force, he once proposed a battlefield RF weapons system: "You could make an antenna that could be carried by a helicopter and this could be expected to produce a wide variety of symptoms by humans who happened to be standing in the beam."

Alternately, a highly tuned RF device could act as sort of a negative pacemaker, inducing heart attacks by overriding the heart's normal "P" wave. Such a device would produce a specific EMP set at a specific frequency and power level that would cause cardiac fibrillation, or heart attack. Such a device could immobilize or kill large numbers of troops.

Nor are RF weapons the only electromagnetic anti-personnel devices now under consideration. Some military actions -- certain kinds of Marine Corps assaults, for example -- might require that destructive effects be minimized and casualties prevented. For those purposes, a disabling but non-lethal technology would be ideal. To that end, the United States has experimented with the effects of ELF (extremely low frequency) signals on animals.

Between 1981 and 1982, for example, a study conducted at the Armed Forces Radiobiology Research Institute in Bethesda bombarded rats with various ELF rays of various intensities and frequencies. (ELF signals are those below 3,000 cycles per second; frequencies used in the experiments ranged from 3.33 to 9.41 Hz.)

The researchers' report confirmed that "extremely low frequency, low power em signals can: a) possibly cause behavioral changes in animals; b) interact with cells to cause rather immediate chemical changes in living systems; c) cause long-term effects, such as hormonal imbalances, bone growth, etc.; and d) interact directly with neurons in the brains of humans, causing firing rate entrainment of specific neurons and/or sets of neurons."

Such an ELF device, the researchers suggested, "would be useful in dispersing crowds and in temporarily disabling potential prisoners."

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