RFI: INVISIBLE KILLER?

Does Radio Frequency Interference—today's electronic clutter of the air-waves—cause those mysterious plane crashes, missile failures and communications blackouts?

By RICHARD HAITCH

On the docks at the Oakland Army Terminal in California the eerie, invisible "force" had stabbed once more. The giant steel unloading cranes seemed haunted with electrical current, and crews were being shocked and painfully burned. The stevedores had been unloading ammunition ships; now they laid down their equipment and refused to work. For too long they had moved gingerly, trying to outmaneuver the peril.

Investigators diagnosed the Oakland mystery as another attack by an increasingly active foe called Radio Frequency Interference—or RFI. Anyone who owns a television set has probably been bothered by RFI; it can split the TV image into fragments or obscure it with flickering bands or specks of light. For the viewer the interference is merely annoying. But RFI at its worst imperils human life and property. It blocks communications. It regularly holds up the launching of some United States missiles and has caused others to malfunction temporarily in flight. It has made the nation's military defense system and attack potential a frightening gamble. Some electronics specialists are convinced that unless Radio Frequency Interference is reduced drastically, the country must someday consider dictatorial control by the Federal Government of all electrical energy. For RFI is the result of energy that all types of electrical devices spew into the air; it is an emission of electrical energy from one device strong enough to upset the operation of another.

At the Oakland Terminal, for example, investigators found that the steel unloading cranes were acting as antennas, picking up transmissions from daytime radio station KSAY, whose transmitter is a half mile away. The cranes in turn threw off an electric current that burned the crews. This electronic freak has defied remedy, and the Army has been forced to unload its ammunition and other supplies at night, when the station is off the air. At last reports the Army was suing for a permanent solution to the problem—a court-ordered change of KSAY's power or a change in the location of its transmitter.

Stories about RFI often crop up in newspapers, mainly as amusing, offbeat occurrences. The radio-controlled garage doors of a Greenwich, Connecticut, doctor open inexplicably during the night, and the papers report that he is troubled with electronic "spooks." But the real peril in RFI seldom makes news.

In the not-so-distant days of Edison's first electric light and Marconi's first wireless set, there was no problem of Radio Frequency Interference. RFI arose as the output of electrical devices soared to fill human demands for more and more mechanization, greater and greater comfort. Millions of devices now clutter the air with their electrical emissions. A partial list would include about 2,000,000 radio transmitters in the United States alone, the thousands of public and private TV transmitters, the millions of receivers, plus medical and business machines, radars, fluorescent lights and any number of household appliances. It would be impossible to inventory all the potential sources of RFI.

If the waves of energy put out by all the electric and electronic devices in the world could be observed in the air as moving strands of wire, we would find ourselves enmeshed in an amazing jungle of contorted metal. If by some legerdemain we could separate the wires and trace them to their origins, we would see that they vary in shape and length—some fat, some thin, some many thousands of miles long, others as short as five or ten feet—or even inches. The wires would be extremely active, undulating out from their points of origin and darting hither and yon like nervous reptiles, seeking entry to any other electrical devices attuned to their size.

The diabolic thing about RFI is that the interfering equipment can range from the most potently complex to the simplest and smallest. Emissions from a radio station in Spain early this year hampered the tracking of a U.S. satellite before the offending signals were pinpointed and eliminated through the co-operation of the Spanish government. At Minneapolis, worn contacts in an electronic-doorbell system in a private home let current shoot out into the airways briefly every four minutes. For a day and a night it was impossible for Wold Chamberlain Field, a half mile away, to maintain clear radio contact with approaching and departing airliners. And in New Orleans a neighbor's "wireless baby sitter" snarled broadcasting reception up to four miles away.

One should not infer that these are extreme illustrations of RFI. The record of cases grows fatter every day, and such random examples as these are part of it:

- A fly, activating an electric fly-killing device in a restaurant at Logan Airport, Boston, caused the near crash of an Air National Guard plane. Investigation disclosed that the fly killer had broadcast a signal that cut into landing instructions radioed to the plane.
- Another near accident was recorded at a Detroit airport when an arc welder blotted out vital portions of a call from an approaching aircraft.
- When interference plagued radio messages sent by the fire department at East Palestine, Ohio, the offending signal was traced to a radio beacon in Bristol, England. The Kentucky State Police, on the other hand, found its emergency radio communications in a flood area being broken up by a signal from a Government radio station in Alaska.
- Radiations from an electronic heater in a furniture factory in Martinsville, Virginia, simultaneously disrupted communications at two widely separated points—the Mackay Radio and Telegraph Company in New York City and a secret Federal radio station in Fort Lauderdale, Florida.

Case after case could be cited. So numerous are they that the Field Engineering and Monitoring Bureau of the Federal Communications Commission, the U.S. agency charged with tracking down RFI, handles only the more serious complaints. The problems of thousands upon thousands of citizens—poor television reception, for example—are generally viewed as not sufficiently grave to merit attention.

To track RFI, the FCC maintains a network of eighteen long-range radio detection stations, as well as mobile and hand detection units in thirty-one field offices. The network enables the agency to take bearings on far-reaching interference as it is refracted from the ionosphere. Two or more bearings are plotted on a map in Washington, D.C., and the intersection of the bearings indicates the general area of RFI. With further bearings, taken and plotted in antenna-equipped cars, local investigators narrow the search still more, until finally, with the aid of listening devices, they can close in on offenders.

When human life is at stake the FCC steps in quickly, and remarkably efficiently for its limited staff, once the hazard has been brought to its attention. The Government, for example, has warned pilots not to rely on certain air-navigation aids in the vicinity of some major cities. It has banned the use of portable FM radios by passengers in all airliners.

After the mid-air collision of two airliners over New York City last December, the Civil Aeronautics Board began investigating the possibility that RFI had made it impossible for the jetliner in the disaster to obtain an accurate radio-navigation bearing, and thus caused it to stray from its assigned path. Shortly after the investigation started, the FCC enforcement chief in New York, acting under new, sweeping powers conferred by the commission, ordered five factories in the metropolitan area to halt at once the operation of electronic equipment that was radiating excessively on frequencies used by air-navigation beacons. The factories were forced to shut down. It so happens that the approach area used by the colliding planes is a hotbed of Radio Frequency Interference from electronic heaters in nearby industrial plants. No one has proved beyond a doubt that RFI caused the collision, but the suspicion lingers, as it does in many an air disaster.

The simple fact is that every piece of electrical equipment is a potential source of interference to other equipment. But cluttered as the atmosphere is with electrical transmissions and bad as the interference between them is, it is bound to become worse. New sources of Radio Frequency Interference are being created daily. The armed services of the United States now depend heavily on electronic equipment, not only to gather and collate intelligence about possible foes but also to make command decisions. Soon a combination of radar and computers will take over from humans, to a large extent, the control of all civilian traffic along the nation's airways. In ten years, an official of the Westinghouse Electric Corporation confidently predicts, computers and related electronic data-processing equipment should be in universal commercial use, even by the store on the corner.

Electronics specialists are worried. "The art of interference control is a tricky one, and new tricks are appearing every day," says Rexford Daniels, head of a crusading civilian group, Interference Consultants, Inc., of Boston. Writing in an engineers' publication, the *IRE Student Quarterly*, he gives examples.

> A technician puts too sharp a bend in a hookup wire, and he has made an antenna; an engineer plugs in a power cord and finds that he has created a "ground loop"; a test man leaves a piece of wire lying on a bench and finds that it is resonating; a windstorm blows a copper flashing loose, and it becomes a relay station. When you get fooling around in the microvolt areas, even the change in your pocket can upset readings. . . . Comparatively few people know, or care, about this growing menace except those who wonder when a plane will crash, a ship will be lost or a guided missile will land in a crowded city.

Is Daniels exaggerating? At Cape Canaveral, Florida, at least one missile—an early Matador type, since redesigned — maneuvered erratically when a woman taxi dispatcher in Austin, Texas, radioed instructions to a driver. The dispatcher's voice, which the Matador picked up, was identical in pitch to the radio signal used to guide the missile. Nearly one in every five launchings at the Cape is delayed in the countdown stage by interference to data-transmission channels from a variety of sources.

"In spite of elaborate precautionary measures taken to prevent interference from occurring," Richard E. Jones, area-frequency co-ordinator of the Atlantic Missile Range, told a recent conference of electronics engineers, "cases still arise which are serious enough to threaten the success of an entire launching operation. When interference does occur, it usually happens at the worst possible time and is not usually recognized as interference at the outset, but as equipment malfunction."

An Air Force specialist, Col. James D. Flashman, chief of frequency allocation in the Directorate of Communications-Electronics, has commented bluntly in *Signal*, the official journal of the Armed Forces Communications and Electronics Association:

> Under concepts by which the frequency spectrum is now used, it is just not possible to guarantee that any portion of the spectrum will be interference free, regardless of national or international intentions or agreements. Controls which would make this guarantee possible simply do not exist. Internationally recognized distress frequencies are probably among the most sacred assignments known; yet these frequencies are seriously abused, not just occasionally but continuously, as mounting reports readily disclose.

Compounding the problem of RFI are the formidable twins of electronic progress—power and speed. The power of equipment—radar in particular—has increased tremendously in recent years. Military radar is now so strong that it can actually cook a man exposed excessively to its rays. The more powerful the equipment, the more likely it is to interfere with other equipment. At the same time the speed of transmitting electrical impulses has increased fantastically. Computers now transmit data at the rate of hundreds of thousands of "bits," or segments, every second. A few seconds' interruption can be ruinous.

Where can the blame for Radio Frequency Interference be placed? One knowledgeable electronics engineer, who prefers to remain anonymous, speaks of ignorance among designers and manufacturers of electronic devices. "If the people who design the equipment know the problem, the problem no longer exists," he contends. "They would adopt methods to control interference, if they knew the peril in their uncontrolled equipment."

For years this engineer has been in the forefront of a small battle being waged by a professional group, the Institute of Radio Engineers, to educate other engineers to the seriousness of RFI and the need to control it, in designing equipment, before manufacturing begins.

So far as military equipment is concerned, any impartial analysis would have to lay part of the blame for RFI at the door of the armed forces themselves. Since World War II—and in some branches even before—the American military has been aware of the growing threat of Radio Frequency Interference. An impressive catalogue of military directives and specifications has been drawn up over the years, aimed at ensuring that new equipment built for the armed forces would not create new problems of RFI. But what has appeared an enlightened solution on paper has proved an added menace in practice.

The military has largely ignored its own careful standards for controlling RFI. More than half of its orders for new equipment, according to one informed military estimate, have been accompanied by waivers to manufacturers, permitting them to side-step rigid anti-RFI specifications.

In some cases such waivers have been the result of honest attempts to meet a nightmarish dilemma. Weakened by rapid demobilization after World War II, the services have been working hard to prepare for a possible World War III. New equipment has been needed fast. Anti-RFI measures can add time and expense to the development of equipment. The armed forces have tried in some cases to weigh the risk of increasing RFI against the risk of being caught shy of modern equipment in a sneak attack by an enemy, but in the end they have ordered the equipment and waived the anti-RFI specifications. The fact that such equipment might ultimately not work accurately in combat because of RFI hasn't made the choice any easier. More than one defense commander has spent a sleepless night worrying whether RFI might paralyze his equipment before it ever goes into action.

Last year Maj. Gen. Robert J. Wood of the Army Research and Development Office, noting that the modern battlefield was "overrun" with electronic devices, asked the House Defense Appropriations Subcommittee to authorize a two-year $8,700,000 study program to find out what would happen if 20,000 such gadgets were operating at once under war conditions. He feared the result would be a hopeless snarl of the airwaves, with devices jamming one another. The study is now under way at the U.S. Army Electronic Proving Ground at Fort Huachuca, Arizona, and yielding important data.

Concern over the effectiveness of military equipment has finally prompted the Defense Department to unite the individual efforts of the Army, Navy and Air Force in the first comprehensive assault on RFI. Last year Deputy Secretary of Defense James H. Douglas told the secretaries of the three military branches in a message: "The increasing use of the radio-frequency spectrum and greater reliance on radiating devices for military purposes is resulting in a Radio Frequency Interference problem that is of great concern." He outlined a Radio Frequency Compatibility Program and ordered it into action at once.

The program is an enormously ambitious attempt to "fingerprint" every type of electronic equipment owned by the military—to determine all the energy radiations of the equipment and to analyze these radiations for potential interference with other equipment. The data—"spectrum signatures," the military calls them—are to be stored in a central library for use in predicting RFI at a given military site.

An analysis center is now being set up at Annapolis, Maryland, under the direction of civilian RFI experts from the Armour Research Foundation of Chicago. In full operation, the center will reduce all the radiation information on military equipment to mathematical equations. Electrical energy in the environment — from all civilian sources, as well as possible jamming that an enemy might introduce—is also to be estimated mathematically. Then computers at the analysis center are to tell how the equipment will perform in combat. Finally this information is to be tested in the field.

The military is hopeful about the compatibility program, possibly more hopeful than it has been about RFI at any time in the past. Where the computers detect interference, the armed forces hope to outflank it through such means as time-sharing of present equipment—permitting the use of equipment only at specified intervals—and alteration of the design of future equipment. But no responsible official is kidding himself into thinking that RFI has yet been contained. The obstacles to even partial success of the compatibility program are great.

For one thing, if frequency conflicts arise between civilian and military equipment, which gets the priority? Traditionally the civilian has tended to prevail in peacetime. Another obstacle is the vast ignorance about the nature of RFI. "We don't know enough about radio frequency propagations about what to put into the analysis center's computer," a defense co-ordinator admits. "It's pretty hard to form an equation that describes the effect on equipment of, say, an airplane passing overhead or a truck roaring by." (The airplane's radio and other electrical equipment and the truck's ignition system can create RFI.)

A third roadblock is the massiveness and complexity of the task itself. Getting spectrum signatures for every type of equipment, for example will require thousands upon thousands of man hours. Some experts estimate this task could take as long as three years, unless more funds and technicians are made available.

Meanwhile on the civilian front the war against RFI hobbles along aimlessly, if indeed it can be said to be moving at all. The FCC's Field Engineering and Monitoring Bureau, the police department of the airways, is hopelessly ill equipped to cope with the magnitude of the threat. In all the fifty states the bureau has a total staff of only 380 to handle complaints, track interference, license amateurs, aid ships and planes in distress and serve the public in other ways. Of the 380 staffers, only about fifty are assigned specifically to investigate violations. And only half of the work of these fifty is concerned explicitly with curbing RFI.

But even if the FCC's police force were increased fivefold or sixfold—and it could easily use the extra manpower—the agency could never solve the problem of RFI. It simply lacks the power to proceed effectively. It is a stopgap and not a solution. It is authorized to crack down only *after* RFI has occurred, after the damage has been done. Even then it is frequently strapped by a lack of legal authority unless specific danger to life or property can be proved. Often it must wheedle, humor, even shame offenders into eliminating interference by using shielding or otherwise modifying their equipment.

What is needed—and sorely—is a coordinated civilian-military program to control all RFI. Prevention calls for laws to force the designers of all electric and electronic equipment to make sure their products don't release energy that will interfere with other equipment. Such laws will require that the products meet authorized standards of performance before they can be sold. Just as cities such as Los Angeles have been forced to demand action from the automobile industry and others to control pollution of the air that is breathed, so the Government will have to insist that manufacturers not pollute the electro-magnetic spectrum with unwanted radiations.

Programs that approach this goal are being carried out today in Europe. Great Britain, Germany, Sweden, Norway, Switzerland and the Soviet Union, for instance, have strict laws governing the amount of unwanted energy that electric and electronic devices—even the ignition systems of motor scooters—can emit before they reach the customer. Canada, too, has exacting laws.

Thus far, however, Congress has resisted, as an intrusion on trade, attempts to legislate control over the design of electrical equipment in the United States. The person who uses the product —not the manufacturer—is held responsible for its performance. The Federal Government has no compunction about insisting on safety checks on an airliner before it is allowed in the sky, but it will not lift a finger to monitor the design of electrical equipment that may one day cause the accidental crash of the aircraft.

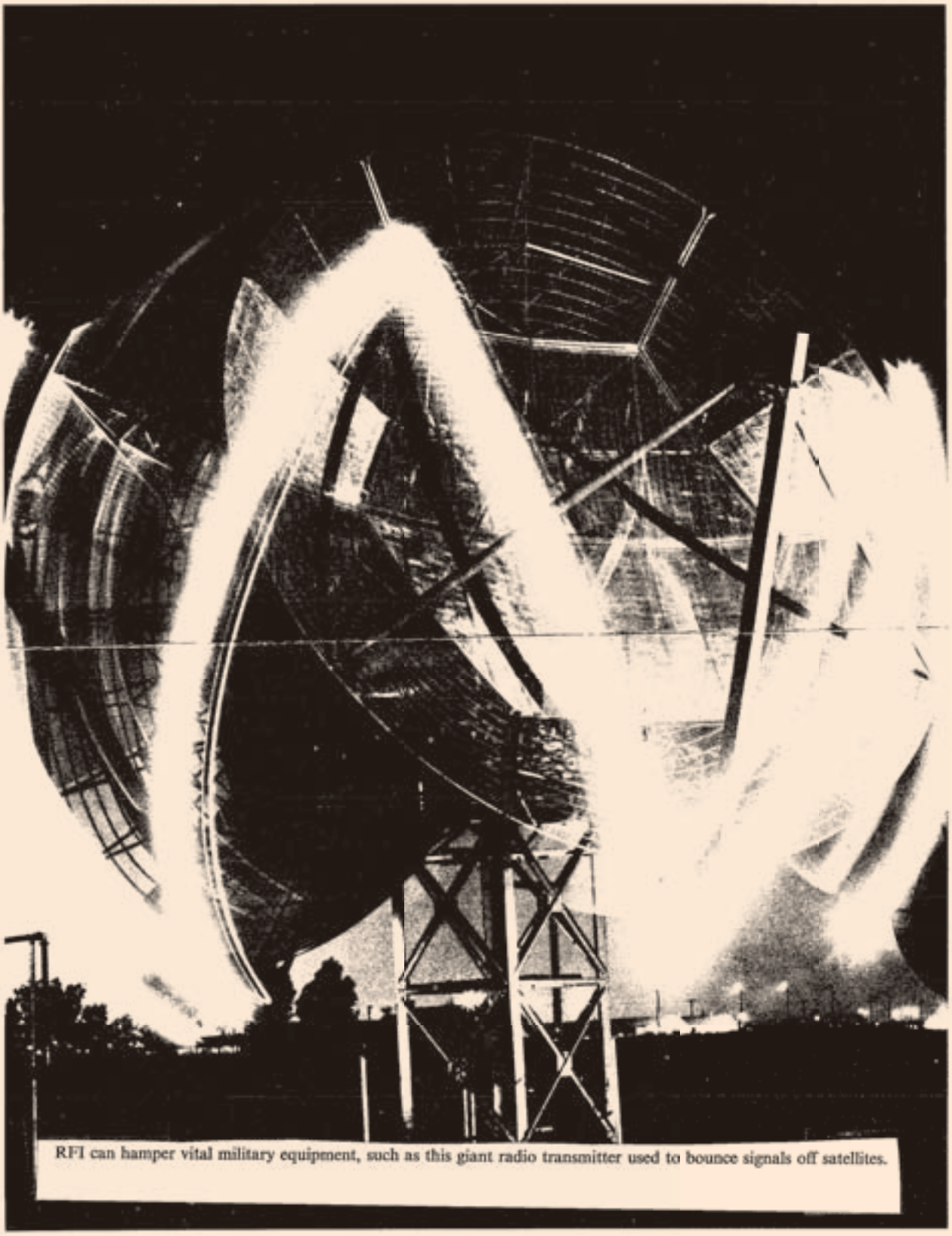
From the standpoint of national defense, one thing is certain: The problem of RFI must be approached with a greater sense of urgency. A visitor concerned with RFI was talking recently to a responsible Army officer in the Pentagon. "Let me ask you this," the visitor said. "If World War III broke out tomorrow, would this country be in bad shape with respect to Radio Frequency Interference?"

"We'd be in serious trouble," the officer replied.

Tradition dies hard, and the tradition of maximum free enterprise and civilian dominance over the military has proved sound in this country since its adoption by the founding fathers. But worried electronics experts are questioning whether tradition should not have some give to it. As they see it, the alternative to some legal control of RFI promptly is drastic legal control eventually—dictatorial rule by the Federal Government of all electric and electronic energy. This step might be necessary, some specialists have suggested, on days on which particularly vital space missions are scheduled or during international crises.

Though few laymen are aware of it, the machinery for such total control already exists, embodied in Public Law 200, enacted in 1951. This law empowers the President, upon proclamation "that there exists war or a threat of war, or a state of public peril or disaster or other national emergency," to "cause the closing of any station for radio communications, or any device capable of emitting electromagnetic radiations between 10 kilocycles and 100,000 megacycles" - more than 99.9 per cent of all electrical equipment built today. Public Law 200 could be invoked by a proclamation that RFI is a "public peril."

Not long ago a musician was strumming his electric guitar when it suddenly broadcast a message from a passing airplane. One newspaper headlined its report HIS GUITAR TALKS BACK! It was RFI, of course, that was doing the talking; and those who know most about the RFI menace think it's time we all got the message. THE END



RFI can hamper vital military equipment, such as this giant radio transmitter used to bounce signals off satellites.