SHELTER FROM THE SURGE, PART 1

Understanding Electromagnetic Pulse

By Gary V. Small

HAVE you ever heard of EMP, and if you have, do you know what it is? Unfortunately, very few people can answer in the affirmative. EMP, which stands for Electromagnetic Pulse, is a little-publicized phenomenon associated with nuclear explosions. Due to the fact that EMP is not directly harmful to humans, it has been lost among the more spectacular and deadly effects of a nuclear burst — but its potential effect on equipment could prove far more destructive.

When a nuclear weapon is detonated, it generates heat, light and blast effects, all of which are known and have been observed. Less well-known, and harder to detect, is the massive pulse of radio energy that is also generated. This pulse is so great that it can interrupt, damage or destroy electrical and electronic equipment over a wide area.

EMP is a topic of which there has been a scarcity of information, compared to that on the effects of blast, heat and fallout. One of the reasons for this is that EMP is apparent only in weapons detonated in the air. Since in-air testing has been banned since 1962, the study of EMP has been hampered, and there is limited information available with regard to actual field tests. The remoteness of in-air test sites is undoubtedly a contributing factor to the lack of available data.

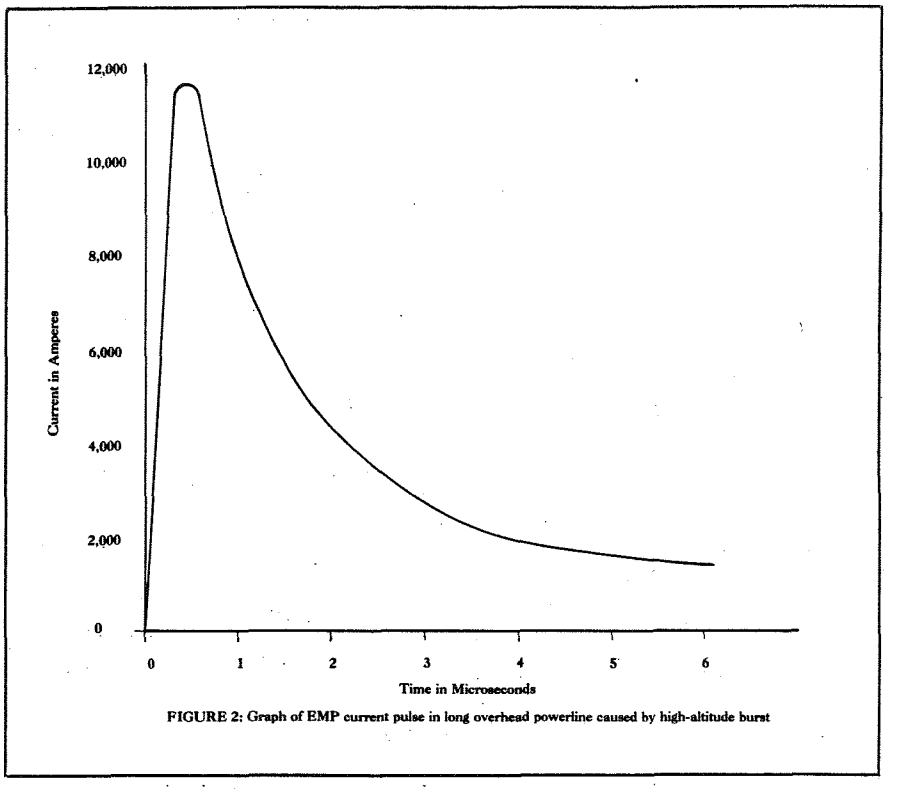

FIGURE 2: Graph of EMP current pulse in long overhead powerline caused by high-altitude burst

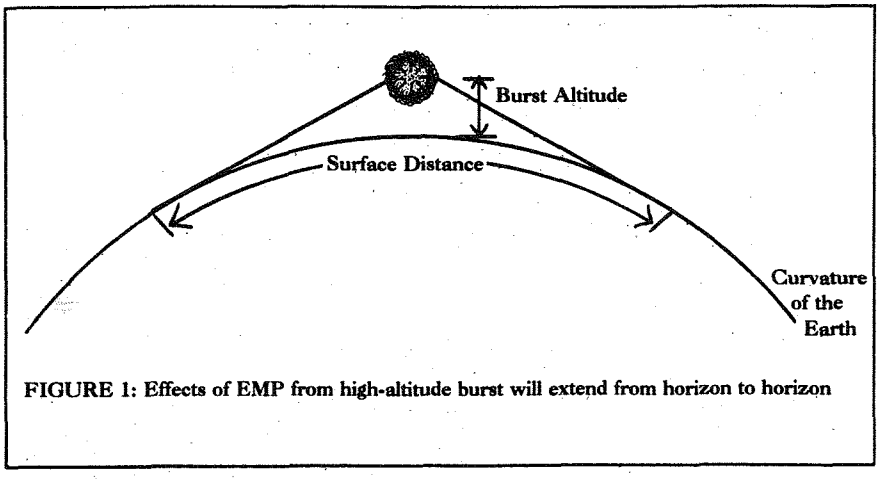

FIGURE 1: Effects of EMP from high-altitude burst will extend from horizon to horizon

Finally, much of the electronic equipment which is most susceptible to EMP, such as solid-state computers and radios, did not exist in the early 1960s.

However, research on EMP has continued, utilizing simulators and underground nuclear tests. As a result, both private industry and government have instituted major programs to determine the vulnerability of vital equipment and how to protect it against the effects of EMP.

EMP is a short-duration, high-energy pulse similar to a radio wave. The pulse contains radio energies across a broad band of frequencies from VLF to the VHF range, generally from 0-150 MHz. The electric field of this pulse may be millions of times stronger than a typical radio wave, and can induce a pulse reaching thousands of volts into radio

TABLE 1

Detonation Height	Radius of Coverage (at Ground Level)
30	486
40	560
50	626
60	685
70	739
80	789
90	836
100	881
120	963
160	1107
200	1233
260	1397
300	1495
340	1585

Note: All distances are in miles

antennas of moderate size. Due to the extremely rapid rise time of the pulse, much of the current protection equipment available, such as filters and lightning arrestors, is partially or completely ineffective against EMP.

EMP produces a very large, very short voltage surge in any metallic conductor within range, such as power and telephone lines, radio antennas, railroad tracks, conduit, piping and any other sizable piece of metal. This pulse is then transferred by antennas or power lines to computers, communications equipment and other electrical gear. Depending upon the nature of the equipment, its operation may be temporarily interrupted, or it may be permanently damaged. Computers and radio equipment are particularly sensitive to EMP, and much of the telephone network, power grids and individual power plants are now computer-controlled. EMP is to electrical equipment what blast is to buildings. Imagine the results if every piece of electrical gear in an area were subjected to its own private lightning bolt!

There are two distinct manifestations of EMP that are of particular concern: high-altitude burst and low-altitude (or ground or surface) burst. For a low-altitude air burst, the direct range of EMP is within the confines of the range of blast damage. For a one-megaton weapon, the radius of direct EMP is about eight miles. However, the strength of the pulse within this area is quite great, and there is a very real danger that the EMP may be carried far beyond the limits of blast damage by means of power and telephone lines. An EMP-induced surge in power lines may be carried for miles beyond the blast area, damaging electronic equipment wherever it is connected to the AC power grid.

For a high-altitude nuclear burst, say above 19 miles, the mechanism and nature of EMP changes. In this case, the strength of EMP at any given point on the earth is somewhat less then that produced by a low-altitude burst, but the EMP field extends from horizon to horizon for the altitude of the detonation (see Figure 1). Furthermore, the field strength does not significantly fall off with distance. Thus, a nuclear weapon detonated at an altitude of about 200 miles could affect the entire continental U.S. plus parts of Canada and Mexico. The implication is that a single burst could simultaneously disrupt and/or damage computers, communications equipment and similar hardware all across the country.

Figure 2 is a graph of the expected surge that would occur in a long overhead power line. Notice that the current surge peaks at nearly 12,000 amperes within less than a microsecond (one-millionth of a second). This kind of current translates to a surge of many thousands of volts — and it would appear simultaneously in hundreds of power lines over a wide area. We can only speculate on the survivability of the highly interconnected power grid which serves this country.

As mentioned before, EMP will be picked up by any kind of metallic network. Table 2 presents a list of typical collectors of EMP energy. Depending upon the particular circumstances, a susceptible piece of equipment may not even have to be physically connected to a collector. With EMP of sufficient magnitude, mere proximity may be sufficient to cause damage.

The main threat from EMP is to solid-state electronics equipment, primarily computers and radio gear. Antennas and power lines will be the primary routes by which damaging electrical surges will reach this equipment, and the damage inflicted may be temporary or permanent, depending upon conditions. (Other electrical equipment may be affected likewise, but is generally less susceptible than equipment containing solid-state devices.) Table 3 presents a list, in order of relative susceptibility, of equipment which could suffer EMP damage.

The best protection from EMP for any piece of equipment is to remove it from connection or proximity to any known EMP collector. EMP generally requires a sizable piece of wire or antenna to reach damaging proportions. Battery-powered radios with short whip-type antennas are generally immune to EMP. Merely turning off a piece of equipment which is

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TABLE 2
Typical Collectors of EMP Energy

- All overhead power and telephone lines
- Metal support towers for power lines
- Metal support towers and guy wires for antennae
- Steel structural girders in buildings and bridges
- Railroad tracks
- Long runs of wire within buildings
- Metal or barbed-wire fencing
- Long runs of steel cable, piping or conduit
- Corrugated roofing or siding
- Large antennae and feed cables
- Cable-TV systems

TABLE 3
Equipment Susceptible to EMP

Most Susceptible
- Digital computer systems and digital control systems
- Any equipment containing semiconductors, transistors or integrated circuits (any equipment considered solid-state)
- Intercom, alarm and communication systems
- Transistorized radio transmitters and receivers

Less Susceptible
- Vacuum-tube radio transmitters and receivers
- Vacuum-tube electronic equipment which does not contain any semiconductor devices
- Telephone and telegraph equipment
- Equipment containing low-current relays and meters

Least Susceptible
- High-voltage AC equipment such as transformers, motors, heavy-duty relays, circuit breakers
- Filament-type lamps
- Heaters

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attached to either AC power or an antenna will not necessarily protect the device. Also, it has been found that many devices designed to protect equipment from lightning or power surges are not very effective against EMP. Such methods are more effective when multiple units of different types are used, such as a filter followed by a lightning arrester.

Although EMP is not directly harmful to humans, it would be a major factor in the overall impact of a nuclear attack. A high-altitude burst, set off specifically to create EMP, could interrupt or damage power distribution, communications and computer operations on a national level. To an individual survivor it represents a threat to his radio equipment and any power-generation equipment he might have, especially if it is tied into the power lines and has solid-state control components. The best protection for this equipment is physical disconnection from a potential EMP collector, including power lines, antennas, water pipes and ground wires. Radio capability should be provided by battery-powered units with short antennas until the EMP danger is past, or a cheap AC radio could be left running as an expendable item. Operational radio gear could play a big part in the individual's survival, and it would be tragic to have one's equipment destroyed just when it will be needed most.

Readers who want to find out more about the technical aspects of EMP should consult *Nuclear War Survival Skills*, by Cresson Kearny (Caroline House Publishers Inc., Dept. SV, 920 W. Industrial Dr., Aurora, IL 60506); *The Effects of Nuclear Weapons*, edited by Samuel Glasstone and Philip J. Dolan (U.S. Dept. of Defense and Dept. of Energy, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402); technical manuals from Bell Laboratories; "The Chaos Factor" in Jan./Feb. *Science 83* and "EMP: A Sleeping Electronic Dragon" by Janet Raloff, Vol. 119, *Science News*.

Don't miss the second part of this series, which will detail a number of valuable practical steps for protecting your communications equipment from EMP. — Eds. □

SHELTER FROM THE SURGE, PART II

How to Protect Your Electronic Components

by H. Walter

THE effects of EMP (Electromagnetic Pulse) from a high-altitude (60 miles or more) nuclear explosion will be devastating to our entire industrial complex; shutting down most electric power, knocking out computers and machinery dependent upon diodes, transistors and semi-conductors, destroying electronic-ignition systems in most of the automobiles on the road and, in effect, throwing our interdependent civilization back into the early 1800s within a fraction of a millisecond. Since the Pacific bomb tests in the early 1950s, this phenomenon has been known to scientists. However, with the rise of "peace"-movement pressures that resulted in a freeze on nuclear testing, our scientific community has been working more or less blindfolded to explore the impact of EMP on our society. The Soviets, on the other hand, know well the terrific damage that can be wrought on our country by the high-altitude detonation of just one nuclear bomb over the midwest — a bomb that can easily be concealed in any one of dozens of their satellites now in position over our country.

I make no pretense of understanding the electronic workings of EMP, and neither will most survivalists. The most pressing question is, "How do we prepare to protect ourselves against the effects of EMP?" A few basics of the phenomenon should be spelled out:

1) There is no threat of radiation, blast or thermal action.
2) EMP will "collect" in exposed power lines, rails, antennas, metal pipes, etc. Wherever these collectors enter a shelter or building, EMP follows, destroying sensitive equipment.
3) Ordinary breakers and lightning-surge arresters are ineffective against EMP, which has a very rapid rise rate and is predicted to reach a level of 50,000 volts with 1,000 amperes.
4) Shielding and pre-blast disconnection are the two most effective methods available to the average non-electronic-oriented survivalist. Use of vacuum tubes makes radio gear less susceptible.

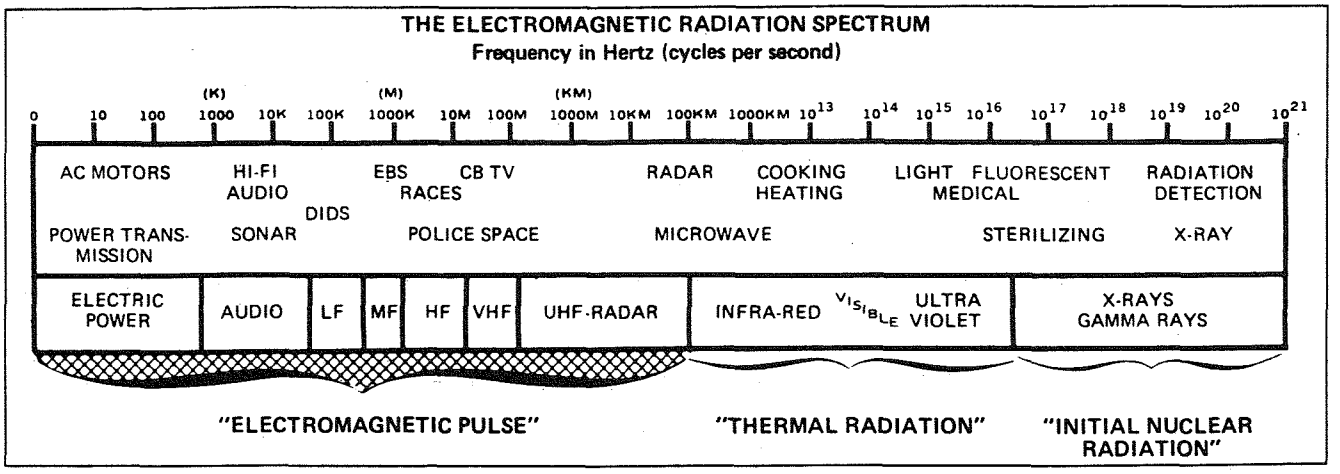
Following are the actual steps that we have taken in our own program to protect our equipment from EMP.

Early Warning

For the alert survivalist, EMP damage will be the first indication that a nuclear attack has started. For example, if you see numbers of automobiles suddenly stopping along the roadside, be suspicious — especially if your car happens to be one of them! If you are in a vehicle with an old-fashioned, non-electronic-ignition system, turn on your car radio to doublecheck. If you cannot tune in any regional stations, you can be reasonably sure that you are on the track of EMP. If it is after dark and the street lights and other city lights have gone out, head for your shelter or pre-planned destination. Do not expect to be able to buy gasoline on the way, for the electric pumps will have stopped working when the power failed.

If you are at home and the power fails, *do not* automatically assume that it is a tree down across the wires or some other type of local outage. Be alert for EMP at all times! Get out your battery-operated, portable shortwave/AM radio and see what you can tune in. If regional stations as well as the local outlets are all dead, start immediately to put your survival plan into operation. If you are in or near a target area, this short-warning notice may be sufficient to enable you to reach your shelter before missiles arrive. If you live well outside any target area, as any realistic survivalist will be sure to do, this warning will give you the time needed to round up your family or group members and prepare for the arrival of fall-out or the inevitable panic in the community when suddenly people are jolted out of their apathy.

A telephone call is *not* a valid test. AT&T is one of the few large companies that has been protecting its equipment against EMP (since 1960), and some major trunk lines may be operational until damaged by direct hits. An early-warning device that I have rigged up (there isn't any way to test it)



consists of an electric blasting cap with an extra length of wire attached. It is hung outside our home so that we can hear the explosion if it should occur anytime, day or night. Thus far, radio signals have not set it off, and logic seems to dictate that EMP will trigger it.

Automotive and Aircraft

The electronic-ignition systems on most newer cars are vulnerable to EMP damage, which would render them inoperable and result in complete disruption of evacuation plans or attempts of group members to reach shelter. If you are distant from your shelter, even if you have adequate time before fallout arrives, you will be stranded. Modern jet aircraft have thousands of electronic circuits which will be blown out, resulting in an instant life-or-death glide-for-safety pattern for any airplanes unfortunate enough to be in the air at the time.

1) Avoid commercial flying. If you must fly, don't have any illusions about surviving if you happen to be unlucky enough to be caught in the air during an EMP surge.
2) Check your automobiles to determine whether they have electronic-ignition systems. Most pre-1975 GM and pre-1973 Chryslers do not. If your car does have electronic ignition, you have several choices:

A) Trade it in on a car with an older ignition system or buy a second-hand car that qualifies. We bought a 1970 GMC ¾-ton pickup truck last spring.

B) Have your mechanic replace all of the electronically activated parts with the older system. This can be rather expensive due to labor costs.

C) Purchase replacement modules that you can carry in your car. We have a 1973 Plymouth Fury and a 1977 Dodge Aspen, both Chrysler products that use the same ignition systems. We purchased two replacement electronic-control modules as well as two electronic-voltage regulators. These parts were left in their cardboard boxes to avoid metal-to-metal contact, wrapped with aluminum foil and then metal (not plastic) wire screening, and placed in a met-

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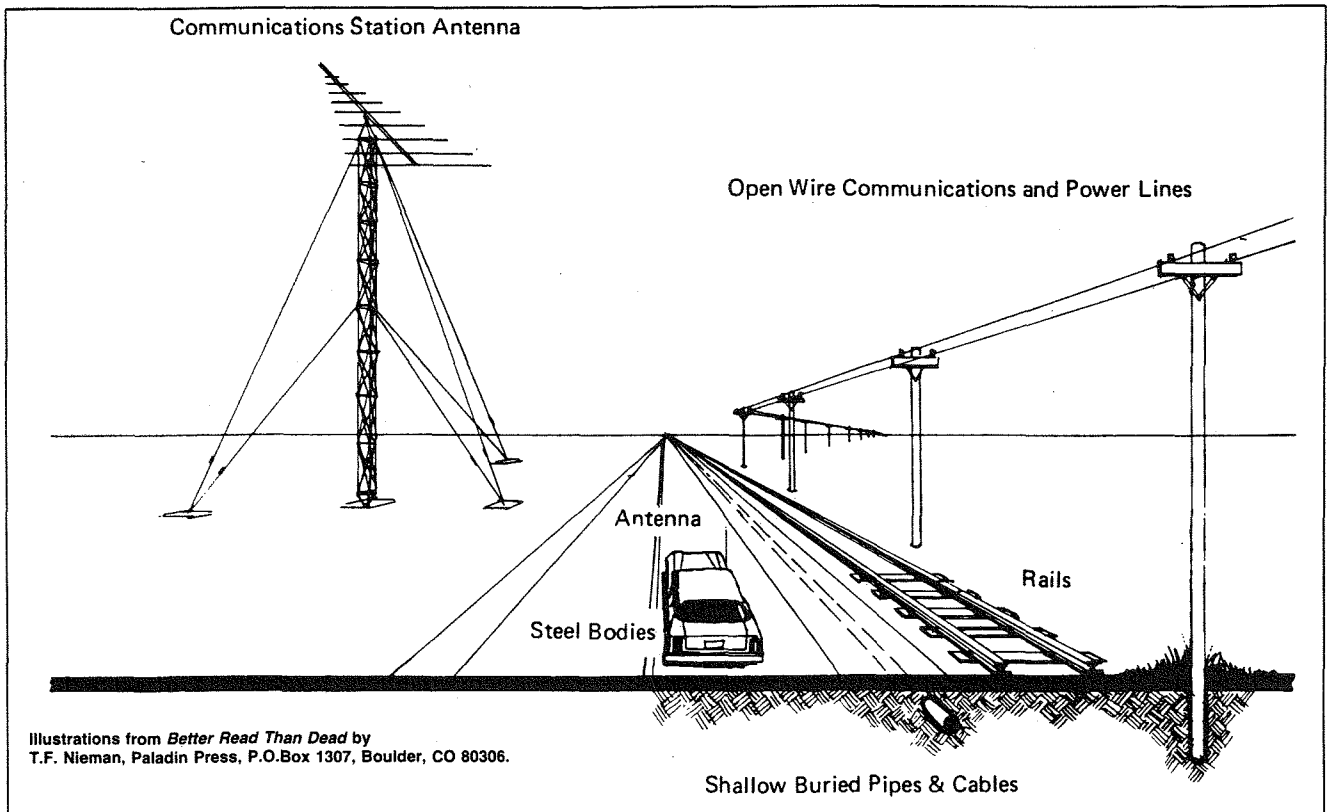

Illustrations from *Better Read Than Dead* by T.F. Nieman, Paladin Press, P.O.Box 1307, Boulder, CO 80306.

EMP ENERGY COLLECTORS

SURGE

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al tool- or tackle-box with a tight cover. Included in this box are a set of 10 or more 20-amp fuses in case the other car circuits are blown, plus a small hex-head wrench that fits the screws holding the modules to the firewell or fender.

Some of the very newest cars have a "black box" that contains all of the electronic components, but it is impossible to get at without taking apart practically the entire front end of the car. Do not misunderstand: All of the above suggestions fall under the category, "Doing the best we can with what we have," and there are no guarantees. When we travel into town, we transfer *both* metal toolboxes into the Chrysler that will be used that day, giving us a double backup.

3) Check your other vehicles — motorcycles, ATCs, etc. — to see whether they have electronic ignitions. I found that our new Honda ATC 200cc "Big Red" does, so I purchased a replacement CDI (Capacity Discharge Ignition) and had it wrapped and stored along with my radio gear. Older-model cycles, tractors and other vehicles usually work off of a magneto and will not be affected by EMP.

Communications

Published government documents tell us that communications equipment employing bipolar transistors with self-contained batteries and loop antennas is not too susceptible to direct EMP damage. Stick antennas up to 40 inches long are *supposed to be* immune if used with similar equipment. In other words, mobile communications equipment is relatively survivable while radio-base stations are vulnerable. Most important to remember is that *all electronic gear must be disconnected from electrical circuits or antennas in order to have any chance of surviving an EMP surge.* Radio equipment manufactured in the 1950s and early '60s that does not contain semiconductors, transistors or diodes, and depends instead upon vacuum tubes, would be preferred for survival use. A reliable source for EMP-resistant communications gear is Fair Radio Sales, Dept. SV, P.O. Box 1105, 1016 Eureka St., Lima, OH 45802, (419) 227-6573. Another source for all types of electronic survival equipment, including EMP-protected radio gear, is Kootenai Radio and Energy Systems, Dept.

Most small-appliance motors are, according to the "experts," less vulnerable than transistorized equipment. Here again, the savvy survivalist will take the "worst-case" approach and prepare for all electrical devices to be knocked out by EMP.

The information put out by our government and used in civilian articles is mostly a rehash of the same data published in 1977 in *The Effects of Nuclear Weapons*. Very few practical suggestions on a non-technical level are given that can benefit the "generalist" who is trying to survive. If any of our readers have more up-to-date information on protective methods or equipment which can be put to use by someone less qualified than a Ph.D. in physics, please send them to H. Walter, P.O. Box 271, Cortez, CO 81321. □