

The Scariest (Disaster) Book I Have Ever Read, Part II



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The most terrifying weapon facing the U.S. may already be in our enemies hands. Are you prepared for the ultimate disaster? In Part II of his three-part series, author Leo Wrobel explains how you can best prepare yourself for an electromagnetic pulse.

In Part I of this series, we discussed how a single, relatively simple device exploded over the U.S. Midwest would generate an electromagnetic pulse, or EMP, that could destroy the whole U.S. power grid and virtually everything connected to it. An EMP attack poses perhaps the ultimate threat to today's contingency planner. Unlike other disasters, which are regional in scope, an EMP could affect the entire nation and push us back almost instantly into a 19th-century economy. There would be no outside help and no one to turn to. An EMP attack would wipe out computers and the Internet. There would be no electricity, perhaps for years. Emergency services would stop, and hospital operating rooms would close. Food distribution would stop. In the ensuing chaos, most Americans would die from starvation in months.

How Lethal Is an EMP Weapon?

Understanding more about what EMP is and how it manifests itself is the first step in planning for such a disaster. Several factors govern the lethality of a nuclear EMP weapon:

- Altitude
- Device yield
- Distance
- Other factors

Altitude

A nuclear detonation high in the atmosphere—in fact, at the edge of space—produces an immediate flux of gamma rays. These gamma rays in turn produce high-energy free electrons. This occurs at altitudes between roughly 10-25 miles. The electrons are then trapped in the Earth's magnetic field, giving rise to an oscillating electric current. This current in turn gives rise to the rapidly rising radiated electromagnetic field known as an *electromagnetic pulse* (EMP).

The Line of sight (LOS) from dozens or hundreds of miles above the earth means the EMP effect can easily span entire continents-sized areas. For example, a large device detonated 250 to 312 miles over Kansas would affect the entire continental U.S. The energy from such an event extends LOS to the visual horizon as seen from the burst point. Note that this altitude is above the orbit of many LEO (Low Earth Orbit) satellites. Therefore, such an EMP could be expected to wreak havoc over those systems as well. Geosynchronous satellites, on the other hand, orbit 22,300 miles up. These systems could in fact survive. For other electronic equipment to be affected, the weapon would need to be within LOS above the visible horizon. In most cases it would be, even if it was partially blocked by mountains or other topography.

Device Yield

Typical nuclear weapon yields used during Cold War planning for EMP attacks were in the range of 1 to 10 megatons, or roughly 50 to 500 times the size of the bombs used at Hiroshima and Nagasaki. Physicists have testified during U.S. Congressional hearings that weapons with yields as low as 10 kilotons or less—roughly half the size of the

Hiroshima bomb, can produce a very large EMP. In fact, small "pure fission weapons like these combined with their cases are much more efficient at causing EMP than most megaton thermonuclear bombs. Ironically, these are somewhat cruder designs, which can be presumed to be easier to build if fissionable material was available.

Distance

An important aspect of nuclear EMP is that all of the components of the pulse are actually generated *outside* of the device. For high-altitude nuclear explosions, this means that much of the EMP is actually generated at a large distance from the detonation point, when gamma radiation hits the upper atmosphere. According to the standard reference text on nuclear weapons effects published by the U.S. Department of Defense:

The peak electric field (and its amplitude) at the Earth's surface from a high-altitude burst will depend upon the explosion yield, the height of the burst, the location of the observer, and the orientation with respect to the geomagnetic field. As a general rule, however, the field strength may be expected to be tens of kilovolts per meter over most of the area receiving the EMP radiation.

It is the peak electric field of the EMP that determines the peak voltage induced in equipment and other electrical conductors on the ground, and most of the damage is determined by induced voltage.

Other Factors

Other governing factors such as local topography and the local strength of the earth's magnetic field (as discussed previously based on latitude) also come into play when predicting the lethality of an EMP device.

Mitigating Against EMP

It has long been known that there are ways to protect against nuclear EMP. Even the EMP Commission determined in its reports that such protections are almost completely absent in the civilian infrastructure of the U.S. Even large sectors of the U.S. military services are no longer protected against EMI to the level they were during the Cold War. Physicists and engineers working in the field emphasize the importance of making electronic equipment and electrical components resistant to EMP, and keeping spare parts on hand, in a protected location, to enable prompt repairs.

What Else Can Be Done?

According to Dr. Peter Vincent Pry (see quotes in Part I), for starters some 100 to 200 large transformers used in electrical transmission should be protected against EMP attack. He says:

The key for our electric power grid are these big transformers. All together, there are about 300 of them. They are absolutely indispensable to the operation of the power grid. If you fry those things, there are only a couple of countries in the world that sell them for export, and it takes a year, at least, to make one of them.

Equally important are myriad small computers that regulate the power grid. Pry surmises:

This country cannot survive for six months without electricity, let alone a year. Everything else would go down after losing electric power. To harden these critical transformers against an attack would cost \$200 to \$400 million.

By comparison, the 2008 federal financial bailout cost \$800 billion. Yet without electricity, no one would have a job nor a bank account.

Pry adds that the Department of Homeland Security has plans for 15 kinds of disasters, but none of the scenarios deals with an EMP attack. Nor, he says, are there any plans afoot at present to harden the power grid.

How Should The Average Person or Company Prepare?

So how do Americans prepare for a potential EMP attack? Because the event would render electrical and

communication systems inoperable, preparedness should include supplies that will allow survival without the usual comforts of home such as electricity and running water.

Remember the Y2K hysteria of a decade ago? Perhaps it's time to dust off similar plans but this time for a more eminent threat. Y2K proposed a scenario that predicted the demise of the electrical grid, as we know it, just like an EMP attack would. Therefore, it is logical to assume that EMP preparation includes putting together a typical disaster kit with food, water, medications, fuel, and personal items. While the U.S. Department of Homeland Security recommends a disaster kit able to sustain a family for two weeks, if expert predictions are correct, recovery from an EMP attack could take months or even years.

A basic disaster kit should include items like the following, but remember, the prospect of months or years without basic electrical, water, and health services adds a whole other dimension to these precautions:

- **Water.** Store one gallon per day per person. A non-electrical water filter capable of safely filtering river or lake water also could be used.
- **Food.** Canned foods, dry mixes, and other staples that do not require refrigeration, cooking, or water and include a hand can opener.
- **Portable, battery-powered radio or television.** Batteries would not be affected by an EMP attack, but if the radio were solid state, it presumably would be. Find a tube or portable hand-crank AM FM NOAA Radio that uses two internal AA rechargeable batteries that recharge after hand-cranking 1 minute for 15 to 20 minutes of use and comes with an emergency light built into it. Or, store a radio or other sensitive electronics in a Faraday Cage.

NOTE

A *Faraday cage* or *Faraday shield* is an enclosure formed by conducting material or by a mesh of such material. Such an enclosure blocks out external static electric fields. Faraday cages are named after the English scientist Michael Faraday, who invented them in 1836.

- **Flashlight and extra batteries.** Also note that many bulbs such as compact fluorescent would not work anymore as they have solid state components. Old-fashioned incandescent lights, however, should still be OK assuming of course there is power available. Several years ago, my wife and I changed all the light bulbs in our home and office to compact fluorescent bulbs. We kept all the old bulbs for exactly this kind of contingency, whether it's EMP or a large power surge.
- **First aid kit.** Obviously.
- **Sanitation and hygiene items.** Envision a year or two without toilet paper, for example.
- **Matches and candles.**
- **Extra clothing, especially if you reside in a cold climate.** Extra clothing and blankets could be useful especially for those whose heat is dependent on electricity or other fuel delivered by local utilities. No oil deliveries and natural gas delivery is also governed in part by solid state components.
- **Kitchen accessories and cooking utensils.** This is very important, especially those that can be used with gas grill or Coleman stove.
- **Cash and gold.**
- **Prescriptions.** This includes medications, eyeglasses, contact lens solutions, and hearing aid batteries.
- **Items for infants.** This includes items such as formula, diapers, bottles, and pacifiers.
- **Other items to meet your unique family needs.**

Other Tips and Considerations

Because power could be down for an extended period of time, a generator could prove useful and another item popular with those who prepared for the Year 2000 scenario. Those who live "off the grid" or, for example, using solar energy exclusively would be much less vulnerable to an EMP event, at least when it comes to electrical needs. It is unclear to me whether the generator should also be stored in a Faraday cage. Many have electronic ignition systems that are solid state and could be affected by the EMP.

A microwave oven can be an efficient Faraday cage for most purposes and can be used for shielding small electronic items. It is important that any microwave oven used for this purpose should have its power cord cut off close to the body of the microwave oven. This should be done both to prevent accidentally turning on the microwave oven with electronics inside and to prevent the power cord from acting as an antenna to conduct EMP into the interior of the oven. Anything that you are hoping to use as an electromagnetic shield should be tested by putting a radio inside of

the shield tuned to a strong FM station. If you can hear the FM station while the dio is inside of the shield, then the shield is not adequate.

Have all computer data that is important to you backed up onto optical media, suchs a CD or DVD. Paper printouts are fine, but after an EMP attack, most of the data on paper printouts will never gt typed back into computers. CC and DVD data, on the other hand, is not affected by EMP. Even if your computers ar destroyed, if the country's economy can get re-built after an EMP attack, then new computers can be purchased om other continents.

Contrary to my earlier statement, according to at least one source (Critical Nationl Infrastructures Report), automobiles and trucks may be more resilient against EMP attacks that what is portyed in most fiction. Although many vehicles would be rendered inoperative, others that are not running at the tin of an EMP will most likely run after they are started again. There is a very high probability that the car will eerience electronic damage outside of the electronic ignition system, and itoes possible that the car may have to be std in an unconventional way. It is als possible that it may be necessary to momentarily disconnect the battery so that th electronic modules can recover. Furthermore, it may be a good idea to have maintenance manual for your car so thatbu, or someone you know, car figure out how to bypass damaged modules in your car

NOTE

Automobiles being more resilient may be an unconfirmed fact, but it makes sense. Gaoline vehicles have a robust amount of electromagnetic shielding around the entire electronic ignition system. Cherwise, the ignition noise from al the automobiles would render radio and television sets unusable, especially car raos.

Looking for data center protection? Iœm told that one effective means for isolatirdisturbances on the power line from electronics equipment is the use of a "double-conversion" type of "true online" UPS(uninterruptable power supply) An EMP coming in on the power line would probably still destroy the UPS, but the UP would have isolated the equipment from the power line transient before failing. It is important to note thœ most UPSes on the market are*not* the "true online" type, and are of very limited usefulness for isolating the equipmnt from the power line, even for ordinary voltage spike. Most inexpensive UPSes let much of the voltage spike hit th equipment before switching to internal battery power. I understand some of the best of the small true online UPS nits are those made by SOLA and Tripp-Lite.

What is a Faraday Cage and How Could It Help?

In 1836, Michael Faraday observed that the charge on a charged conductor resided oiy on its exterior and had no influence on anything enclosed within it. To demonstrate this fact, he built a room coated with metal foil and allowed high-voltage discharges from an electrostatic generator to strike the outside of th room. He used an electroscope to show that there was no electric charge present on the inside of the room's walls. Tis concept can be applied to assuage some of the effect of an EMP.

A Faraday cage is best understood as an approximation to an ideal hollow conducto Externally applied electric fields produce forces on the charge carriers (usually electrons) within the conductor, generating a current that rearrange the charges. Once the charges have rearranged so as to cancel the applied field inde, the current stops.

If a charge is placed inside an ungrounded Faraday cage, the internal face of the cge will be charged to prevent the existence of a field inside the body of the cage. However, this charging of the innr face would re-distribute the charges in the body of the cage. For all intents and purposes, the cage will generœ the same electric field it would generate if it were simply charged by the charge placed inside. If the cage is grouded, however, the excess charges will go to the ground instead of the outer face, so the inner face and the inner chrge will cancel each other out and the rest of the cage would remain neutral. This phenomenon is used, for example, to protect electronic equipment from lightning strikes and other electrostatic discharges. The scan room of a Magnœc Resonance Imaging (MRI) machine is designed as a Faraday cage. This prevents external RF (radio frequency) ignals from being added to data collected from the patient, which would affect the resulting image

A single atmospheric nuclear detonation can cause an electromagnetic pulse equal t100,000 volts per square centimeter on the ground. A single detonation could fry every unprotected computer hip from coast to coast. A Faraday cage can provide a measure of protection, but there are considerations. Objcts inside the cage must be electrically isolated from the walls and from the outside. Moreover, any electric gnal coming from the outside world would need to be isolated before it passes into the Faraday cage. You may have the eferect Faraday cage, but if you have power lines coming into it, you defeat your purpose

One simple and low-budget way to protect small electronic devices is to construct your own Faraday cage using two cardboard boxes, with one fitting tightly inside the other. The outer box is covered with aluminum foil, and a ground wire is then taped to the foil. At the end of the ground wire, attach a small alligator clip. The item to be protected is placed inside the inner box (which acts as insulation from the outer box; remember, it cannot touch the wall itself). A EMP hitting the foil and is bleed away by the ground wire. There are *many* variations on this design, but this one illustrates the principle. If you do a web search on Faraday cage and EMP, a lot of things pop up.

What's Next in Part I

Next time, in the final article in this series we examine the effect of an EMP on infrastructure in general, including electricity, communications, banking and finance, petroleum and natural gas, transportation, food distribution, water systems, emergency services, and government. We will make recommendations on the steps you should be taking now to protect these critical systems.
