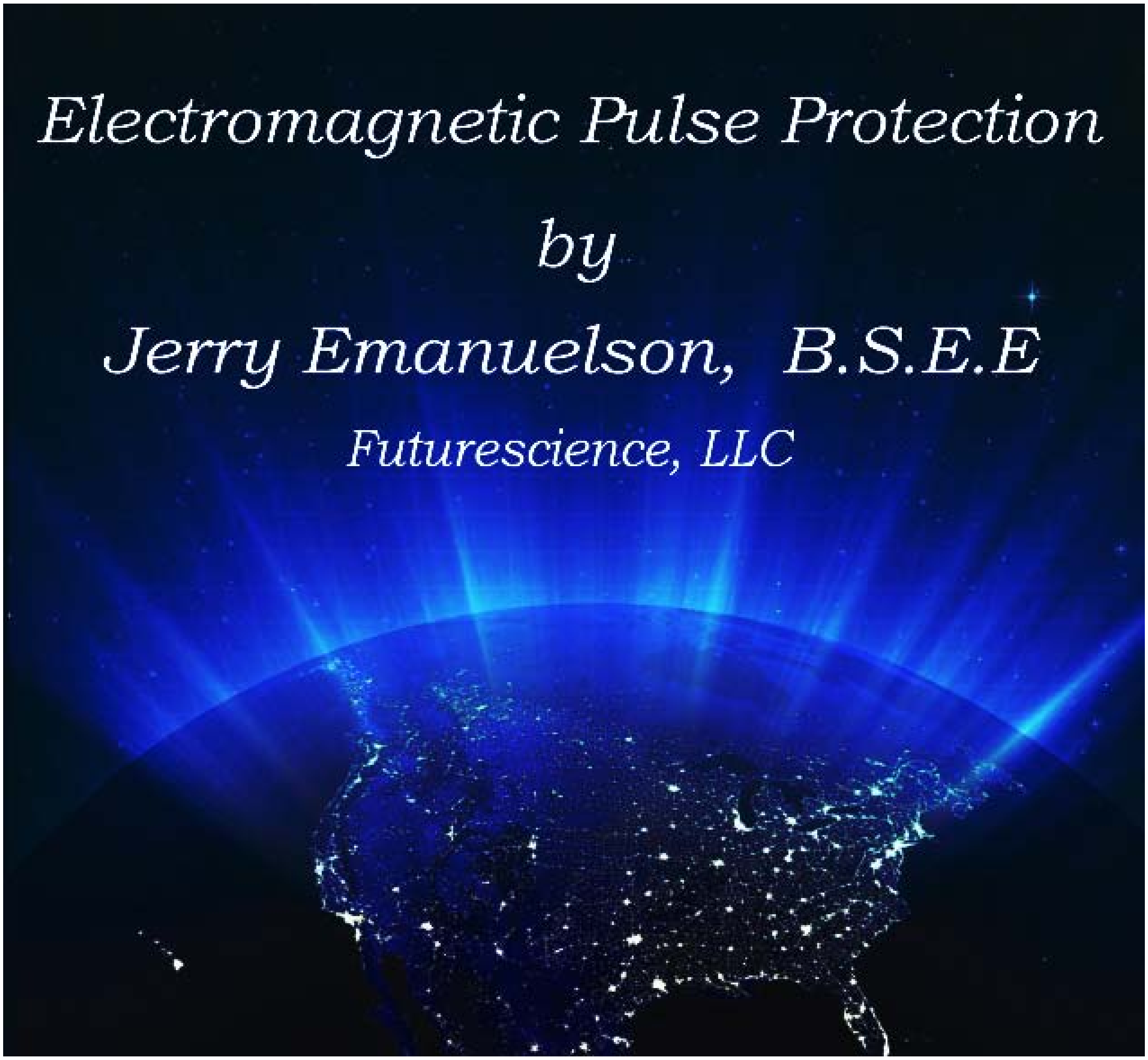


Getting Prepared for an Electromagnetic Pulse Attack or Severe Solar Storm

The science fiction writer Arthur C. Clarke once said:

> ***Any sufficiently advanced technology is indistinguishable from magic.***

This statement is commonly known as Clarke's Third Law. Many people have heard this quotation, but few people really think about its implications.

We now live in a world that is so completely immersed in advanced technology that we depend upon it for our very survival. Most of the actions that we depend upon for our everyday activities -- from flipping a switch to make the lights come on to obtaining all of our food supplies at a nearby supermarket -- are things that any individual from a century ago would consider ***magic***.

Very few people in industrialized countries do work that is not directly assisted by electronic computers, although that computerized assistance is often quite invisible to the average person. Few people think about things such as the fact that whenever we buy some food item at a supermarket (and many others are buying the same item), the next time we go to that same supermarket, they still have about the same supplies that they had before. There are invisible infrastructures all around us that are made up of advanced technology. Most of us just take the magic for granted.

Few people stop to consider what would happen if, in an instant, the magic went away. If our advanced technology were suddenly and completely destroyed, how would we manage to survive? A nuclear EMP could make the magic go away. I hope it never happens, and I don't think that it is at all inevitable. It makes no sense, however, to be blind to the danger. It is both much less likely to happen -- and also less likely to have a catastrophic impact -- if, both as a civilization and as individuals, we are prepared for an attack on our advanced technology. A nuclear EMP would be a seemingly magical attack upon our advanced technology, the technological infrastructure upon which our lives depend.

Among all of the kinds of electromagnetic disturbances that can occur, though, it is important to keep things in perspective. It is possible that a nuclear EMP may never happen where you live. On the other hand, a severe solar storm that will destroy most of the world's power grids appears nearly inevitable at this point. Protection against the damage of a severe solar storm could be done easily and rather inexpensively by the electrical utilities; however it is ***not*** being done, and there are few signs that it will be done. A severe solar storm poses little threat to electronics, but would take down the most important power grids in the world for a period of years. This is a special problem in the United States, and is a severe threat in the eastern United States. So, more important than preparing for a nuclear EMP attack is preparing for all of the ramifications of a severe solar storm which would cause an electrical power outage that would, in most areas, last for a period of years. Most standby power systems would continue to function after a severe solar storm, but supplying the standby power systems with adequate fuel, when the main power grids are offline for years, could become a very critical problem.

In the mid-20th century, electricity was regarded as a ***convenience***. By the end of that century, electricity had become something that most people literally cannot live without for more than a few weeks. This profound change has happened so gradually that very few people have even noticed.

This is a page about some of the things that individuals can do to prepare for an electromagnetic pulse attack or a severe solar storm. I'm an electronics engineer who has been thinking about the EMP problem for more than 3 decades. I even have an ancient Radio Shack TRS-80 Model 4P that has been retrofitted with a complete electromagnetic shield. It's just a personal antique, useless for anything but a personal reminder of how long I've been thinking about this problem. That early-model personal computer didn't even have a hard drive.

I also have a copy of a letter that I wrote to another science writer on March 28, 1987 in which I said, "An EMP attack on the U.S. does seem plausible to me. Three or four (or maybe even one) nuclear weapons detonated in space would instantly shut down the U.S. economy. It would cause billions of dollars worth of direct damage to electronics equipment and a much greater loss in indirect costs to the economy."

I've spent much of my career working with radio and television transmitters on high mountaintops where there is a lot of lightning and other kinds of severe electromagnetic transients. Many engineers who spend their careers working in fairly benign electromagnetic environments don't realize the fragility of our technological infrastructure. On this page, I'm going to concentrate on a nuclear EMP attack, but much of this also applies to natural events such as intense geomagnetic storms resulting from extremely large solar storms.

The threat of a sudden EMP attack that causes a widespread catastrophe is certainly an old problem. Consider this Cold War era quotation from a widely-read and highly-respected publication more than 35 years ago: "The United States is frequently crossed by picture-taking Cosmos series satellites that orbit at a height of 200 to 450 kilometers above the earth. Just one of these satellites, carrying a few pounds of enriched plutonium instead of a camera, might touch off instant coast-to-coast pandemonium: the U.S. power grid going out, all electrical appliances without a separate power supply (televisions, radios, computers, traffic lights) shutting down, commercial telephone lines going dead, special military channels barely working or quickly going silent." -- from "Nuclear Pulse (III): Playing a Wild Card" by William J. Broad in ***Science*** magazine, pages 1248-1251, June 12, 1981.

The situation would be much worse today than in 1981 due to our profound and ever-increasing dependence upon electricity and electronics for the basic maintenance of our lives. In addition, the last remnants of the pre-electrical infrastructure, and the knowledge of how to use the components of that infrastructure, is slowly and completely disappearing. Some people have said that the long-term loss of the power grid would send us back to the 19th century. That belief is quite false because we have no 19th century infrastructure and very little knowledge of the practical use of 19th century infrastructure. A long-term loss of the power grid would send us back to the middle ages for a number of years.

Although much of what is written below is about protecting one's own personal electronic items (especially regarding communications), it is important to remember that the greatest threat, by far, to the life and well-being of you and your family comes from the damage to electrical and electronic systems that are outside of your personal control: ***the national critical infrastructures***.

The bulk of your EMP protection efforts must be directed toward protecting yourself from the results of the loss of the critical infrastructures that support our everyday lives. All of our national critical infrastructures are dependent upon the electrical grid and our electronic infrastructure.

This is necessarily a rather long article because of the large amount of things that must be addressed when confronting the loss of national critical infrastructures, and this article is only a primer. It does not cover everything.

First: Another brief note about severe solar storms (and similar natural events), and then I'll get back to nuclear EMP. Solar storms would primarily affect the power grid, and are not likely to harm things like computers. Also, solar storms would only disrupt communications temporarily, and would not be likely to cause direct harm to communications equipment (except for satellites). An extremely large solar storm, though, would induce geomagnetic currents that could destroy a substantial fraction of the very largest transformers on the power grid (possibly over much of the world). If this happened, electric power loss due to a large solar storm would be out for a period of years and possibly decades. Unlike nuclear EMP, such a solar storm is an eventual inevitability.

The last solar storm that could have caused this level of damage happened in 1859, before the power grid was in place (although in 1921 a large solar storm, of briefer duration than the 1859 event, occurred which affected a much smaller area of the planet). The power grid has only been in place for a fraction of one percent of human history, and a really large solar storm (of the size and duration of the 1859 event) has not happened in that time. There is a general assumption that any solar event that is similar to, or larger than, the 1859 solar superstorm will simply never happen again, although there is ***no*** justification for such an assumption -- in fact, we know that this assumption is false. There is a good possibility that such a large-scale solar storm will happen in this century. If it happens in the current situation without adequate spares for our largest transformers, a large part of the worldwide power grid (including 70 to 100 percent of the United States power grid) will be down for years. It is encouraging, however, that awareness of this problem is growing and supplies of spare transformers are showing some signs of growth.

A 2008 study by Metatech found that the time required to obtain a replacement for any one of the 370 or so largest transformers in the United States was 3 years. In a solar superstorm that affects vulnerable areas of the entire world, delivery times could easily be much longer. The United States, which for many years had no capability to manufacture those transformers (and which is just now regaining that capability), will be at the end of a very long waiting line. Since such a expansion of transformer manufacturing capability requires a lot of electrical power, the capability cannot be developed after an electromagnetic catastrophe. The capability has to be developed before there is an actual critical need. In the past five years, two United States companies have begun the process of expanding into the large transformer business, but it will take a considerable length of time before a reasonable number of spare transformers can be manufactured.

Because of the inevitability of a large solar superstorm, we have to accept the fact that the current electric power grid upon which our lives depend is only a ***temporary*** infrastructure. This temporary infrastructure has served us very well, and we now have entrusted our very lives to it. Of course, it is possible to build a resilient electrical grid. In most countries, such as the United States, though, the will to make the electric grid resilient has been absent.

The fact that the electric power grid began as a convenience, but has become a necessity for sustaining life, is both one of the most beneficial, and one of the most dangerous, facts of 21st century existence.

We do not know how long the current power grid will last; but if it not replaced by a robust permanent infrastructure in time, hundreds of millions of people will die when the electric power grid collapses simultaneously in many countries. How such a collapse occurs is very well known, and the methods to either prevent it, or to have spare transformers in place to fairly quickly repair it, are also well known. Although these preventive measures would not be terribly expensive, they would take some time to put into place; and those things have never been done.

Provisions for insuring islands of power production within the country that would prevent millions of deaths could be put in place fairly quickly, and much less expensively, but this also has never been done -- or, until recently, even been seriously considered, except by the few scientists and engineers who have seriously studied the fragility of the electric power grid. There are finally signs, in 2013 and 2014, that this situation is beginning to change, but the process is very slow.

I am repeatedly asked about "faraday cages" for solar storms and protection of automobiles against solar storms. I must repeat that this is an area where solar storms and nuclear EMP are very different. Solar storms only produce something similar to the E3 component of nuclear EMP. "Faraday cages" are not relevant for solar storms for anyone at ground level (unless you are planning to launch a satellite). Solar storms will not destroy your car, (at least not any of the solar storms that have occurred in the past million years). If you own an electric car, though, it may be wise to avoid charging it during an active severe geomagnetic storm.

Solar storms can, however, prevent your car from operating by preventing you from getting your fuel tank filled due to the lack of electricity at the gas stations. This is another reason to never let the fuel tank in your car get below half full.

Many people who say that they have off-the-grid power systems are interconnected to the power grid in order to sell their excess power back to the main electric grid (what engineers call the bulk power grid). From an EMP or solar storm standpoint, this interconnection presents the worst of all possible worlds. Such an interconnection exposes a so-called off-the-grid system to all of the dangers of the power grid. You can do this, but it just requires many extra levels of protection at the interconnect point (and usually some spare electronics boards).

The gravest danger posed by grid-tie solar power systems are the solar panel systems that are only grid-tie, with no internal transfer switch to allow solar power to be used by the home when the grid power is down. These systems will reduce your electric bill while the the main power grid is working, but that is ALL that they will do. It is very unfortunate that these have recently become the most popular kind of solar power system. If you have a solar power system that goes down when the power grid goes down, you must be aware that your solar panel system will not protect you from EMP, solar storms, cyber-attacks or even ordinary power outages from hurricanes and other storms. All that these common solar panel systems are good for is reducing your electric bill when the power grid is working. This has become such a enormous problem that some companies are now specializing in retrofits to make a solar panel system into a true backup power system. Nuclear EMP poses an additional danger to solar power systems since nuclear EMP can destroy all of the components of an unprotected solar power system. Solar panels (at least of the polycrystalline and monocrystalline silicon type) have proven to be quite resistant to nuclear EMP, in spite of the fact that the solar panels are just semiconductors that are open to the sky. Total EMP protection of a solar panel power system is possible, though, and need not be terribly expensive.

Even though solar storms primarily affect the power grid, customers can communicate the importance of EMP and solar storm protection to their local electric utilities. Devices such as the *SolidGround* system made by Emprimus can be installed by local electric companies on all of their large transformers that are connected to very long lines.

Although a major electromagnetic disturbance that would destroy large parts of the electrical grid is almost inevitable in the next century, it is important to keep things in the proper perspective. There is a reasonable chance that people will come to their senses in time, and have the electrical power grid protected before such an event happens. Although a hardened power grid does not seem likely in the near future, the dangers to the power grid are becoming much more widely known.

Another encouraging trend is the fact that far more people are prepared to be self-sufficient for at least a few weeks than was the case just a few years ago. The greater the number of people who have made at least minimal preparations for a disaster, the smaller will be the overall impact of the disaster.

Even apartment dwellers on a very low income can have a level of preparedness that will be of significant help. By buying an extra can of reasonably nutritious canned food every week or so, you can build up a food reserve -- before you realize it -- that will last you for at least two or three weeks, and probably much longer. Two or three weeks of "breathing room" after a disaster can give you great peace of mind and allow you to stop and think and plan for a future course of action (while the unprepared are all in a great panic). It is even possible that some additional help may arrive after a week or two. The most important thing is to store at least a two-week supply of drinking water. There are many plastic containers of all sizes that can be stored in a closet that won't take up an excessive amount of space.

One example of a convenient container for water storage in small spaces is the one gallon polypropylene plastic bottle that is used for Arizona brand teas. Although these plastic containers are marked with the Resin Identification Code *5* or *7*, the Arizona Beverage Company web site states that (at least, as of November 2013 and earlier) the plastic does not contain any bisphenol-A in the container, so they should be safe for long-term water storage. (As of 2016, the Arizona Beverage web site says nothing about biphenol-A. I don't know what this means.) These one-gallon plastic containers with screw-on plastic lids should be a convenient method of water storage for many people. Do not keep the water in storage for a very long time without refreshing your supply with new water occasionally, though. There are larger containers that are made for long-term water storage for those who have the storage space for a longer-term emergency water supply.

Also, don't forget obvious sources of emergency water like a hot water tank. A hot water tank should be a last resort, though. If the emergency turns out to be short-lived, a tank malfunction could cause problems when the heating for the tank comes back on. Don't let the existence of water sources like a hot water tank make you lazy. Have a supply of emergency water that is both quickly accessible and portable.

What just happened???

The most important piece of information you can have after any sort of unusual electrical event is information about ***what happened***. If there is a bright flash in the sky at the same time that the power goes off, and you've been worried about nuclear EMP, your first reaction may be to assume the worst. There are many other events, however, that can cause a power outage.

If it is a nuclear EMP, though, you will want to know about it right away, and the local radio and television stations are going to all be off the air. Most of the internet will also be down. There might be some telephone service if you are ***very*** lucky, but anyone that you would call probably won't know any more than you. The only way that you will get any timely information will be by listening to broadcasts originating on other continents using a battery-operated shortwave radio.

If you have a shortwave radio, it is likely to be knocked out by the EMP unless it is adequately shielded. To be adequately shielded, it needs to be kept inside of a complete metallic shielded enclosure, commonly known as a faraday cage, and preferably inside nested faraday cages. A faraday cage is an total enclosure made out of a good electrical conductor such as copper or aluminum. (Steel also works well, but it is often more difficult to make a total enclosure with steel.) Large faraday cages can get extremely complicated. For small portable electronics, though, completely covering the electronic equipment in heavy-duty aluminum foil makes a good faraday cage around the equipment. The foil covering needs to be complete, without any gaps. Wrap the device in plastic or put it in an insulated box before wrapping the covered device in foil. (Otherwise, the foil may simply conduct the EMP energy into the device more effectively.) A single layer of foil may not be adequate. In order to enclose the equipment in a nested faraday cage, place the foil-covered device in a plastic bag, such as a freezer bag, and wrap that bag completely in aluminum foil. If you really want to protect the equipment against a large EMP, add another layer of plastic and foil. The layer of plastic needs to be the thickest plastic bags that you can easily find. (They don't need to be terribly thick, but do try to find some heavy-duty bags.)

If you have done an absolutely perfect job with the first layer of aluminum foil, the "nested faraday shield" is not needed. As a practical matter, though, the "nesting" procedure helps greatly in protecting against both inadvertent gaps and possible later accidental punctures through the aluminum foil that may severely compromise the shield.

Just adding many layers of foil directly on top of foil won't do as much good, due to what is called "skin effect." I won't bother to explain skin effect here, but you can look it up if you're curious. Don't worry too much about skin effect, though. I only mention it here because many people have the misconception that when it comes to shielding, the thicker the better -- and this is definitely not true after a certain thickness is reached. Layers of shielding separated by insulation works much better. As a practical matter, though, wrapping with 2 or 3 layers of foil helps to assure that you actually have a good shield around the equipment. Using heavy-duty aluminum foil can prevent the foil from tearing as easily.

Of course, any antennas or power cords need to be either disconnected or contained completely within the faraday cage.

One question that arises frequently is whether a various kinds of safes or galvanized trash cans make an effective faraday cage. Technically, it may not be correct to call either of these a faraday cage because they are not constructed of the best electrical conductors. A locking-lid galvanized metal trash can, though, can be a very effective electromagnetic shield. Although it can be very effective, it is less than perfect, so the interior of the body of the galvanized metal trash can should be lined with some material to electrically insulate items stored inside the container from the metal exterior. (Cardboard probably works better than any other inexpensive material for this. Liners such as plastic trash bags may be too thin for this because of the momentary high voltages that could be induced on the exterior of an imperfect faraday cage during an actual EMP.) Do not place any insulation at a point where it would interfere with the electrical connection between the metal lid and the metal body of the trash can. It is also important to wrap any very sensitive items placed inside the metal trash can with a layer of aluminum foil (preferably in the "nested faraday cage" manner described above).

It is important to remember that a galvanized trash can, by itself, is usually an imperfect shield. It may be good enough for many purposes (such as for storing items that you use frequently or for less sensitive items), but the extra layer of shielding provided by aluminum foil on equipment that is stored on the inside may be a critical factor in a severe EMP. On a galvanized trash can, the electrical connection between the body of the can and the lid is critical. For this reason, use only a new galvanized trash can for this purpose. Dents and distortions in the roundness of the lid and the upper part of the galvanized can severely deteriorate the high-frequency shielding effectiveness of the can. Also, the lid must be kept very firmly in place for a galvanized trash can to be an effective shield.

The best kind of galvanized trash can to use is one with a handle that also serves to lock the lid in place. These are generally only available in smaller sized trash cans. The locking lid trash cans made by Behrens, and sold by stores such as Home Depot and Lowes, often make excellent electromagnetic shields. The Behrens locking lid trash cans are only available in 6 and 10 gallon sizes (and the 10 gallon size is rather difficult to find). In general, if you read the online reviews and find that the most common complaint is the very tight-fitting lid, then the trash can will probably make an excellent shield.

If you use one of these new galvanized cans with a very round top and lid, as well as a very firmly-secured and tight-fitting lid with plenty of overlap onto the body of the can, then the shielding effectiveness is often excellent. In this case, you may be able to omit any extra shielding, especially for items that you may use frequently. When there is radio frequency leakage in a well-sealed galvanized can, it is usually in the frequencies above 500 MHz. These are, for example, the range of the typical cell phone frequencies, and EMP components at these frequencies are at a very low levels in nuclear weapons that have so far been tested above ground.

You can seal the trash can against more advanced EMP weapons that produce a pulse with higher frequency content, but this is usually done at the cost of the convenience offered by the metal trash can. There are several things that can be done to better seal the connection between the lid and the body of a metal trash can. The metal EMI finger stock that is made for this purpose would cost about twice as much as the new trash can itself; so this is not the best option, although it is feasible if you want to spend the money. Simpler options are to stuff steel wool or aluminum foil under the edge of the lid (after it has been closed). Also, you can seal the lid to the body using aluminum tape. Be sure to use tape that is actually metallic aluminum. You can buy aluminum tape from electronics suppliers that has a conductive adhesive. Often, the conductive adhesive is not necessary unless you are trying to shield frequencies well into the upper microwave range. A good aluminum-backed tape to use for this purpose is 3M 3340 foil tape, which can be purchased at any building materials store. The 3M 3340 tape is 2.5 inches (63.5 mm) wide, which give it a good overlap for sealing the potential gaps in a metal container.

Because of variations in the construction of the Behrens locking lid trash cans, it is best to use the 3M 3340 2.5-inch foil tape to tape over the vertical seams on the inside of the trash can. It may also be a good idea to tape over the seam between the bottom of the trash can and the sides on the interior of the trash can. Of course, this should be done before adding any interior insulation to the can.

Don't try to clean up and re-use any kind of used trash can for this purpose. You need a new one with no dents at all in the lid or where the body attaches to the lid. When you buy these in a store, they will often have several, so you can choose one with a tight fitting lid and with no visible dents.

I should point out that if you have a faraday cage made of a perfect conductor that is also perfectly sealed, then you don't need any inner non-conductive lining to insulate it from the items inside. In such a situation, the outer skin of the faraday cage will block all of the outside signal from even getting to the inner surface of the container. Practical situations are never that perfect.

Nested electromagnetic shields are always best for reasons that have to do only with practical everyday reality. In the case of a galvanized trash can, the best shield can be made by putting a smaller trash can inside of a larger one. (Getting a small can to physically fit inside of what appears to be a larger one is something that is often more difficult than it first appears.) Use an insulating separator to keep the two trash cans electrically isolated from on another. put your equipment in the inner (smaller) trash can. If there is room, you can store some less-sensitive items outside of the inner can.

The question about using various kinds of safes as an electromagnetic shield cannot be answered because there are so many variations in construction that would affect the shielding efficiency. In particular, the electrical connection between the door and the rest of the safe is usually not very good at all. Such a safe probably has some shielding effectiveness, but in most cases, the shielding is very minimal. In general, most safes are nearly useless; but a properly prepared locking-lid galvanized trash can will often be very effective.

Many people have tried to use metal filing cabinets as electromagnetic shields, but they usually provide very little in the way of shielding effectiveness. (The interiors can be retrofitted with wire mesh, but your efforts are usually best expended with more straightforward faraday shields.)

You'll need to keep plenty of batteries on hand for your radios. There are some models of shortwave radios that have hand-crank or solar power, but those "emergency radios" that I've tried don't have very good shortwave reception (although, as explained below, many inexpensive shortwave radios could suddenly become very adequate after an EMP event). A common complaint about radios that use hand-crank power is that the hand cranks are not very sturdy, however the radios will continue to function by using conventional battery power (or solar power if it is available.) If you do use the hand crank on an emergency radio, though, do not treat the hand crank too roughly. I still recommend keeping plenty of batteries on hand.

Energizer makes lithium batteries with a 15 year shelf life. Although small batteries were not damaged during the 1962 high-altitude nuclear tests, it would be wise to store each sealed package of batteries wrapped in a layer of aluminum foil. Future EMPs may be much larger than the 1962 events. Also, battery technology is evolving and the sensitivity of newer types of batteries to EMP is unknown (although the cylindrical batteries tend to provide a certain amount of shielding just due to the way that they are constructed.). I generally prefer ***Energizer*** batteries for cylindrical batteries (AA, AAA, C and D sizes) and ***Duracell*** for 9-volt batteries. The 9-volt batteries contain 6 internal cells in series. In the ***Duracell*** 9-volt batteries, the cells are spot welded together, whereas most other popular brands use a simple press-fit interconnect for the cells. The ***Duracell*** spot-weld method generally makes for a much more reliable connection in this type of battery.

Expect battery technology to be a rapidly-expanding area, though. Duracell has (in some respects) leaped past the Energizer lithium AA and AAA batteries with the Duracell Quantum batteries (introduced in late 2013) with a guaranteed shelf life of 10 years, and which now outperforms the Energizer lithium in some performance tests.

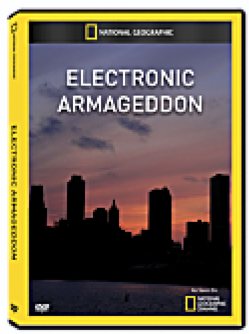
The idea behind having a shortwave radio is to be able to directly receive radio stations on another continent that has been unaffected by the EMP. The radio that I like best of the portable, and not too expensive, receivers is the SONY ICF-SW7600GR. This model is not cheap, but you can usually find it for at least 25 percent below its "list price."

Another good shortwave radio for the price is the Grundig Traveller II Digital G8. This Grundig radio is much less expensive than the SONY ICF-SW7600GR. You can usually find the Grundig G8 for around 50 U.S. dollars. In using the Grundig radio recently, my only complaint was that it seemed to be far more susceptible to electrical noise than many other shortwave radios. Electrical noise is always a problem when listening to distant shortwave stations, but, of course, in a post-EMP situation, electrical noise would cease to be a problem.

Many people have legitimate complaints about nearly any shortwave radio that can be purchased for less than 300 U.S. dollars. Those complaints are often valid if the radio is to be used frequently in today's high levels of electrical noise and radio frequency interference. In a post-EMP situation, or any situation where the regional electric grid goes down, the situation will be very different. In today's electrical environment, certain items like dimmer switches can render almost any shortwave radio unusable inside the building where the dimmer switch is located.

I expect to have some better recommendations for radio receivers on this page sometime in the future.

Keep in mind also that shortwave stations in many countries have stopped beaming their signal toward the United States since so many people simply listen to these broadcasts over the internet. Also, many of the shortwave stations that do come in clearly are using signal repeaters based close to the United States (mostly in northern Canada) and these might be damaged by an EMP attack. Many shortwave stations without repeaters or a beam toward North America can still be heard in the United States. In addition, it is likely that many English-language shortwave stations would re-configure their antenna pattern for better reception in North America after a nuclear EMP attack on the United States.



National Geographic EMP
Documentary DVD

Many people have bought or kept old vacuum tube radios for use after an EMP attack. Although vacuum tubes are thousands of times more resistant to EMP than transistors (and discrete transistors are much more resistant than integrated circuits), other components of vacuum tubes radios can be damaged by EMP. In fact, vacuum tube radios actually *were* damaged in 1962 high-altitude nuclear tests. Vacuum tube radios also have the disadvantage of requiring much more power than solid-state radios, and electric power will be a rare commodity after a nuclear EMP. Although a vacuum tube radio would have a high likelihood of coming through an EMP event undamaged as long as it was turned off and not connected to an antenna, a modern solid-state shortwave radio kept inside of a nested faraday cage is the best form of insurance for obtaining information after an EMP event (and it is preferable that the shielded radio also be stored inside a galvanized trash can as mentioned above).

(Many people don't realize that most vacuum tube radios still in existence have an early solid-state device called a selenium rectifier that is quite vulnerable to EMP damage. These selenium rectifiers would be one of the first things hit inside the radio from EMP coming in on the power cord. Although replacement selenium rectifiers are still sold for old radios, they are difficult to find, and you would probably find them to be completely impossible to get after an EMP attack.)

One important misconception about electromagnetic shielding is the common belief that it should be "all or nothing." When it comes to critical small spare items like an emergency radio, it is important to go to some extra trouble to insure the best shielding possible. Simple small nested faraday cages are so simple and inexpensive that you might as well make sure that a few items are very well shielded. When it comes to less critical items, though, such as items that you use frequently, a less-complete electromagnetic shield could easily make the difference between having equipment that survives an EMP and equipment that does not survive. It is a very common misconception that certain items must have military-grade shielding and other items are nothing to worry about at all. Real world electromagnetic disturbances are much more messy than that. (See the either-or myth on the EMP Myths Page.)

A nuclear EMP will severely disrupt the upper atmosphere for a while, so it could be several hours after an EMP before you get decent shortwave reception with any radio, but that will be long before you could get information from any other source. If you're in the United States, you may be able to get emergency information from a local NOAA Weather Radio station. I believe that a few NOAA emergency transmitters are EMP-protected, but most are not. Repairs to many of these transmitters may be able to be made by military personnel, who can also supply emergency power to them for a while, but that emergency power may not last very long. If you're in the United States, though, it is important to have a NOAA Weather Radio. Canada also has an identical weather radio service. These radios really are inexpensive, and whenever the NOAA transmitters are working, they can provide local information that is critically important. Like your shortwave radio, an emergency NOAA Weather radio needs to be kept in a nested faraday cage until you need it. NOAA Weather Radios could be especially important in the case of a large solar superstorm, where the radios would probably continue to work and give information, even though much of the power grid could be out for months, or even years.

Many people severely underestimate the need for information in any kind of a disaster. In recent examples of long-term disasters (such as the breakdown of civilization in the former Yugoslavia in the 1990s), many people actually died while undertaking risky activities in order to obtain information. Many 21st century humans have an addiction to information that (although it has greatly improved their standard of living) would cause them to take even greater risks than people did only a generation earlier. The important thing is to think about the importance of information well before any sort of a disaster happens.

There have been attempts to start programs to enable communications with individuals when the power grid is down. These programs are difficult to get started because most people don't believe that a disaster will ever happen to them until a disaster actually strikes them personally. Fewer still can foresee a long-term power grid outage as being a personal disaster for them. Some radio amateurs have EMP-hardened equipment, and even more radio amateurs regularly practice providing emergency communications among disaster relief agencies and emergency providers. Very few radio amateurs, though, have ever thought about the necessity of providing regular information to large numbers of individuals in the general public during a very long-term and large-scale power outage.

LED and CFL lights: LED lights (and, to a lesser extent, compact fluorescent lights) can be very useful for post-EMP use because of their efficiency at a time when very little electricity may be available. Both LED lights and CFL lights, though, are *very* sensitive to EMP. I have many LED lights currently in use in my own home, however, and I plan to buy more. I especially like the Cree brand. The price has come down to the point where LED lights are better than either CFLs or incandescents in nearly every respect, especially with regard to their very long life under normal conditions. CFL bulbs are rapidly becoming an obsolete technology since LED bulbs are superior in every way. Even the LED bulb market has not yet fully matured though. Some brands of LED lights do not last very long simply because of very poor design and quality control. A badly-made product of any kind will fail quickly.

LED lights are solid-state diodes that are made to conduct electricity on one direction only. In the case of LED lights, the LED itself has a very low reverse breakdown voltage. Most LED lights will handle a fairly large voltage spike in the forward direction, but not in the reverse direction. LED lights are currently the most efficient form of lighting that is available. LED lights also can last for a very long time. I know of one case where a device that I built at a television transmitter site in 1980 has some of the older (1970s) type of LED indicator lights that have been operating continuously (24 hours a day) for more than 37 years.

LED lights are inherently DC devices. The LED bulbs made for AC use have a very efficient solid-state AC-to-DC converter built into the base of the lamp. Some manufacturers of cheap LED bulbs, though, are doing a very poor job of quality control, especially of the the circuits in the base of the LED lamps. In general, you get what you pay for.

Incandescent lights are also sensitive to EMP if they are in the socket and turned on.

In fact, I have seen incandescent lights literally explode in an EMP simulator. I cannot think of any advantage that incandescent lights have over LED lights, especially regarding EMP.

Compact fluorescent lights can probably be stored without any kind of EMP protection because the base of the light is so small that they are unlikely to pick up enough voltage for the imbedded transistors to be damaged. CFL bulbs are almost certain, however, to be damaged if they are in a socket at the time of an EMP since they have two switching transistors embedded into the base of the CFL. These switching transistors, although they are out of sight, would very likely be damaged by high voltages picked up by any wiring external to the CFL device itself. CFL lights, though, have practically become obsolete by now. LED lights made for AC use nearly all have a similar switching power supply in the base that is very sensitive to EMP.

Although many LED flashlights are likely to survive an EMP simply because of their small size, the sensitivity of LEDs makes the survival of unprotected flashlights less than certain. Also, many LED flashlights contain additional sensitive circuitry. The small flashlights with an all-metal case are the most likely to survive. Because of the importance of having at least one good flashlight when the power grid is down for a long period of time, it would be a good idea to store at least one LED flashlight in a nested faraday shield.

Site Map of all of the Futurescience EMP Pages

If you learn that you have been in an EMP attack, don't make any premature assumptions about how bad it may have been. It may have just hit a part of the country, or it may have been with a relatively ineffective weapon so that the power grid may be back up and running in a few days or weeks. It also could be from a large weapon, or multiple weapons, that totally destroyed the critical infrastructure of the country. There is an enormous spectrum of possibilities for an EMP attack. Don't be fooled by the ***either-or*** myth, or any of the other common EMP Myths that are discussed elsewhere on this web site.

Much of what has been written elsewhere about faraday cages is based upon the assumption that the faraday cage is going to be a room or building sized structure. Large professionally-built faraday cages need to be well-grounded, but for smaller faraday cages, such as you would use to shield a radio or a laptop computer, any wire running to a ground is likely to just function as an *antenna*, and possibly as a very efficient antenna for gathering EMP. Grounding for EMP is a ***very*** specialized area of technology. In fact, grounding for just about any application other than simple static discharge or some basic kinds of electrical safety are also very specialized areas of technology.

As the Soviets learned in 1962, even large underground conductors (such as underground power lines) can absorb huge induced currents from nuclear EMP. The same thing can happen to underground conductors like cold water pipes, which are used for more primitive types of grounding. In a nuclear EMP, a cold water pipe ground may become a large underground antenna if it is connected to a long underground pipe. Although these underground pipes probably won't pick up very much of the fast E1 pulse, they can pick up rather large DC-like currents, and you don't need unexpected electrical currents coming from what you thought was a ground connection. (The corrosion of underground pipelines due to the electric currents induced by frequently-occurring moderate solar storms has been a well-known problem for decades.)

For shielding small items like radios and other electronics equipment, use the nested faraday cage system of alternating foil (or screen) and plastic, and don't bother with the ground connection (unless you plan to physically bury your equipment). EMP grounding gets *very* tricky, and the ordinary rules for grounding do not apply. (Most high-power transmitter antennas are actually at a DC ground.)

I sometimes regret using the term ***faraday cage*** at all because that term has a very specific meaning in the engineering world, and few non-engineers understand the difference between a faraday cage and a partial (but possibly quite adequate) electromagnetic shield. A steel enclosure is not a good enough electrical conductor to be called a faraday cage, but it may provide enough electromagnetic shielding to protect its contents (as long as it is galvanized or unpainted). Many military grade EMP shields rely mostly on steel, but the shield must be a total shield that is professionally constructed. Things like steel office cabinets are nearly useless as an electromagnetic shield without an extreme amount of modification.

A related popular myth is that there is a sharp and well-defined boundary between what is protected from EMP and what is not.

Military systems have very rigid specifications for electromagnetic shielding because they are trying to protect against a multitude of unknown factors. Unless an individual has a very large amount of available wealth, such a high level of protection is probably not going to be relevant for an individual (unless you are building a new house that you want to be EMP-proof). The level of shielding that is adequate in any particular case depends upon a great many factors, including the strength of the EMP, the distance and direction to the weapon and the electromagnetic sensitivity of the particular equipment that you are trying to protect. This electromagnetic sensitivity varies greatly with every electronic device, and the sensitivity changes rapidly as technologies change.

A few days after an EMP attack, a lot of people will become really terrified as their food and water supplies run out, and they discover that there is no way to obtain fresh supplies. Within two or three weeks, the military services will likely come to the rescue for many people. If the size of the attack has been very large, though, that period of relief will probably not last very long. An even larger problem for food distribution is that any kind of centrally-directed distribution, no matter how well-intentioned, is highly inefficient. If you drive into any very large city with enough food for everyone, no centralized organization has ever figured out how to devise a mechanism that is anything close to being as efficient as the marketplace to get the food to everyone. In any case, most people will soon simply begin to starve to death.

For many people, their first concern regarding an EMP attack or a solar superstorm is the protection of their personal electronics, or even their automobiles (even though the worst solar superstorm won't damage electronics or automobiles like a nuclear EMP can do). For nearly everyone, though, the first real problem they will face will come from the loss of power to the pumps that supply their water -- and with the computers that maintain the only local food supplies. Although most individuals cannot do anything to protect critical infrastructure computers or to protect the power to critical central utility water pumps and sewage systems, some advanced planning can increase the chances that you will have an adequate supply of food and water.

Whatever the scope of the EMP attack, the longer that you can remain at home and be fairly self-sufficient, the better things will be for you. This is likely to be especially true during the first few weeks after the EMP event. In most industrialized countries, it is not customary for individuals to keep very much in the way of emergency supplies in their homes. In fact, many people who do keep many emergency supplies are regarded with some suspicion, thought to be "survivalists" or some other strange breed of humans. Disasters are frequent enough, though, that any prudent individual should maintain some basic level of self-sufficiency. Most people in industrialized countries see large-scale emergencies happening frequently on television, while maintaining the irrational and completely unwarranted assumption that it will never happen to them. Therefore, it is the people who do not plan for personal emergencies who ought to be regarded with suspicion as a strange and irrational breed of human.

There are several very reliable companies that specialize in these emergency supplies. The MREs (meals ready to eat) used by military services, especially during emergencies, have to be made on an industrial scale, and they are available for sale to individuals during non-emergency times. The MREs are not the best choice for emergency supplies, though, because of the limited lifetime compared to canned dehydrated and canned freeze-dried food. MREs are convenient, though, and will usually remain fresh for about 5 years from the date of packaging. Many of these same companies that sell MREs also sell freeze-dried food in cans, which have a far longer shelf life and a much lower daily relative cost. After any sort of large-scale disaster, these supplies are only going to be available from government agencies and a few charities such as the Red Cross, and they will only have a finite supply. Many basic emergency supplies can be purchased in advance of the emergency from reputable companies that have been selling these emergency food supplies for many years. The food that these companies sell normally has a shelf life of 5 to 25 years or more, depending upon exactly how it is prepared and packaged. Freeze-dried foods packaged in cans normally have a shelf life of at least 25 years. Although I do not want to get into the process of naming companies, one that I believe to be one of the best, especially for those who have not thought about the subject before, is Emergency Essentials.

For any emergency food supplies that you do get, it is important to get food that you personally like and are actually likely to use, even if a personal emergency never happens. Then, if an emergency does happen, it will be you, not distant relief workers, who will determine what the content of your food supply is. If you get food that you actually like, you will be motivated to actually use it, and you won't have to throw it out as it approaches its maximum storable life.

Some people, who have not thought things through very well, keep only grains as an emergency food supply. Although some raw grains have a very long shelf life and a high calorie density, they do not have an adequate spectrum of nutrients for long-term use without supplementation. In any emergency situation where scarcity of food is a long-term problem, we are likely to see the return of long-forgotten nutritional diseases such as scurvy and various kinds of other vitamin deficiencies, especially of the B vitamins and vitamin D.

Don't forget about water. Few people keep an emergency supply of water, in spite of the fact that it is inexpensive and easy to do. Almost every country of the world has a period of days every year where many people in some large area are without drinkable water. In most countries, nearly all of the water is pumped by electric motors. After a major EMP attack or a solar superstorm, electricity for most of those pumps is going to be unavailable for a very long period of time. It would be easy for most cities to have a protected emergency electrical supply in place for critical pumps; but, like most EMP protection activity, although it is easy to do and could possibly save millions of lives, it is not being done.

A good source of information and products in a situation where the electric grid is down, especially for obtaining well water in such a situation, is the Lehmans web site. Lehmans sells galvanized well buckets, which are long narrow metal buckets that will retrieve water from a well when the pumps aren't working. Metal well buckets can also be used to retrieve fuel from underground fuel tanks when the pumps are not working. Lehmans is often out of stock of these galvanized well buckets. They have been getting to be difficult to find since people have gotten concerned about the fragility of the electric grid, but having a well bucket can be life-saving.

It is also a good idea to have plenty of fire extinguishers. The immediate aftermath of either a nuclear EMP attack or a large solar superstorm is likely to result in a number of fires, along with the elimination of the water necessary to extinguish the fires. Both the E3 component of a nuclear electromagnetic pulse, as well as the DC-like currents induced by a large solar superstorm, are likely to overheat thousands of transformers that are connected to long wires. Although it is the destruction of the very large transformers in the power grid that could keep the power grid from being restored for many years -- many much smaller transformers, such as those on utility poles, and spread throughout suburban neighborhoods, are at risk of overheating to the point that they cause fires. Although the great majority of the smaller transformers are almost certain to survive, many of these transformers are extremely old. Some small fraction of them are likely to severely overheat and cause fires. The percentage of these power pole transformers that cause fires will likely be extremely low, but there are so many of them that the numbers of transformer-caused fires could still be very high.

Medicine is another very important thing that must be considered. If there are medicines that are required by someone in your household, it is ***always*** prudent to have an extra supply on hand. In many countries, insurance restricts the amount of medicine that you can buy. It is often actually less expensive to pay the full price for prescription medicine, especially when generics are available. Buying prescription medicine out of your own pocket makes it much easier to stockpile a supply for emergencies. There is a fairly new web site operated by a physician that discusses the problem of medicine storage for use during disasters. See the Armageddon Medicine site.

If you want to really be part of the solution, instead of part of the problem, and increase the probability that the country can return to normal within a few years after an EMP attack, then you can be prepared to become part of the new infrastructure. The more electronics equipment that you can store under nested faraday shielding, the better. If you want to be able to use that electronics equipment after the batteries run down, you will need a personal power source. A simple small electric generator, one that does not depend upon electronics to start or run, is always a good idea. After an EMP attack, though, fuel for the generator will be a scarce commodity. Solar panels can be used to supply a small amount of electricity indefinitely, especially if you also have some good rechargeable batteries that match the voltage of your solar panel. If you have something like a 50 watt solar panel, you can store it in a nested faraday cage. Only very rare individuals are going to be able to have full electric power after an EMP attack, no matter what advance preparations they might like to make. In a post-pulse world, though, any amount of reasonably reliable electricity is going to be a real personal luxury.

Sol-Ark claims to have EMP-resistant complete solar power systems, and their videos appear to be from people who know what they are talking about. For more information about EMP-resistant solar power systems, see EMP-Hardened Photovoltaic Generators: A Possible Emergency Power Solution for Critical Infrastructure. (This is an important recent report from the Swiss Federal Government.)

Remember that in a complete solar photovoltaic system, the inverters and battery chargers need to have proper shielding and transient protection. Batteries do not need transient protection. Silicon-based solar panels (being sold at the time of this writing) do not appear to need shielding, but the panels DO need TVS (transient voltage suppression) diodes at the output of each panel to block voltage transients from being conducted into the panels from the external wiring.

On new solar installations, every effort should be made to insure that only metal conduits (not PVC) are used everywhere wiring conduit is used in the solar installation.

Many solar panel technologies are under development for future sale, and these may or may not be sensitive to direct radiated EMP. To the best of my knowledge, the thin-film technologies (now mostly used in large utility-scale projects) have never been tested for sensitivity to direct radiated EMP. The only EMP tests have been done on panels that use Schottky diodes for the bypass diodes. When the newer active-component devices come into use for the bypass-diode function, those new panels will have to be EMP-tested.

If solar panels using newer technology are found to be sensitive to direct radiated EMP, the front of the panel can be covered with high-transparency mesh, and the rear of the panel can be covered with either wire mesh or heavy-duty metal foil.

The high-transparency stainless steel mesh, pictured above in front of a computer screen, is a 3-inch x 3-inch piece of 50 mesh stainless steel wire cloth. It is what is between the two strips of brown tape.

If you plan to use solar cells or battery power, you will probably want to keep a small inverter under shielding. Inverters that can step up ordinary 12 volt DC power to a few hundred watts of household AC are not terribly expensive. For people who own protected photovoltaic solar cells, a number of DC-powered appliances have recently become available. There are also a number of DC appliances that are designed for recreational vehicles, but that can be used elsewhere. Transient protection (capable of reacting to the fast E1 pulse) must be supplied on the electronic components of any solar cell system, such as the inputs and outputs of charge controllers and inverters. Any wire runs of any length should be shielded. Do not use PVC conduit. Any system used for standby power should use only metal conduit for all electrical wiring.

If you're trying to protect an existing solar panel system, protecting the wiring (even if it is shielded) from transients will require the services of someone knowledgeable in EMP transient protection. In most cases, the most economical solution is to keep spare components, especially inverters and charge controllers, stored under electromagnetic shielding.

Another web page on this site has some general suggestions about residential standby generators, especially whole-house standby generators. (Writing and maintaining the page on generators has been difficult due to the very wide variety of situations that need to be addressed.) This seems to be a subject of intense interest. The more widespread availability of these whole-house generators is a very good thing, but most of the whole-house standby generators sold in recent years are controlled by electronics that are very sensitive to nuclear EMP (and even to nearby lightning strikes). Standby generators are very ***unlikely*** to be damaged by severe solar storms, although severe solar storms would greatly impact the available fuel supply. There are methods of greatly reducing the vulnerability of standby generators to nuclear EMP and other severe voltage transients.

If you do have access to post-EMP electricity sufficient to run a microwave oven occasionally, that can be a very efficient way of cooking food in many situations. Microwave ovens are about 30 times as efficient as conventional means for cooking food. The problem is that most microwave ovens couldn't be turned on after an EMP event due to the sensitivity of the solid-state control circuitry. The magnetron that generates the heat in a microwave oven would probably survive an EMP just fine. Microwave ovens are heavily shielded, but the sensitive control circuits are outside of the shielding. A few microwave ovens are controlled by a mechanical timer, and these would probably be fully functional after an EMP event (assuming that you can occasionally get enough electricity to operate them). You can still find mechanical-timer-controlled microwave ovens occasionally, although they are getting harder to find every year. I bought one about six years ago at K-Mart for $40 for post-EMP use. I have occasionally seen small microwave ovens with electro-mechanical controls come back onto the market, although they are getting increasingly difficult to find. Recently, stores like Walmart have started carrying small Haier brand microwave ovens with mechanical controls.

The chamber of an older microwave oven is often an efficient faraday cage for most purposes which can often be used for shielding small electronic items, although this doesn't always work well. It is important that any microwave oven used for this purpose should have its power cord cut off close the 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. It is important to note that many newer microwave ovens have a chamber that is designed to shield microwaves, but may not effectively shield some lower frequencies. 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 nearby strong FM station. If you can hear the FM station while the radio is inside of the shield, then the shield is not adequate. There are so many things that can go wrong with electromagnetic shielding that any shielding that you are using should be tested first using the FM radio test. This test should be repeated using a strong local AM station. (Be sure to remove the batteries from any equipment before putting it in permanent storage, though.)

Laptop computers are generally much easier to protect from EMP than desktop computers. This is true both because of the smaller size of laptop computers and the fact that desktop computers have numerous cables which act as antennas for EMP -- and which conduct the pulse directly to the very sensitive electronics inside the computer. Even laptop computers must be well-shielded and without any connections to unprotected wires. Some unconnected laptop computers may even survive an EMP without additional protection. The U.S. military contractors have developed shielding devices so that laptop computers can continue to be used during EMP attacks. Devices such as these, however, are not available on the commercial market, although it is not difficult to construct such a device using high-transparency 50-mesh stainless steel wire mesh.

Although unprotected computers are not likely to survive an EMP attack, there are things that can be done to increase the probability of the computer working if the EMP detonation is distant or weak. Since copper cables are the weak point of most computers (by acting as an EMP antenna), using fiber optic connections to the computer can improve the potential survivability of computer systems. Corning says that the fiber optic USB cables will be sold through some electronics retailers and they claim the fiber optic USB cables will be competitive in price with conventional copper USB cables. (So far, though, the Corning products are most definitely NOT competive with copper cables.) These fiber optic USB cables include the conversion electronics, including the semiconductor laser, within the USB connectors on the cables. This is a major development toward EMP-resistant computer systems. These fiber optic USB cables are now on the market, but they are far more expensive than ordinary copper USB cables.

If you want to store larger items in a faraday cage, you can use copper screen or aluminum screen. Most commercial faraday cages use copper screen, but copper screen is expensive and is generally only available from online dealers. Bright aluminum screen works almost as well, and aluminum screen can be obtained in rolls at many building supply stores such as Home Depot. Don't worry about the fact that this screen is not a solid material. The size of the tiny ventilation holes in the mesh of ordinary window screen is irrelevant to EMP protection. ***Aluminum*** screen can make a very effective electromagnetic shield. Ordinary ferrous (iron-containing) window screen is not a good material for a faraday cage because it is a poor electrical conductor. A notable exception to this is certain types of stainless steel and galvanized steel screens. (I have more about stainless steel screens elsewhere on this web site.) Iron-containing material such as steel can be an excellent EMP shield, but the problem with things such as ordinary iron-containing screen is the difficulty of getting a good connection between various parts of the screen. The weave of the screen can be a very important factor. (Stainless steel and certain kinds of galvanized steel wire mesh can often be a very good electromagnetic shielding material. It all depends upon the quality of the electrical contact between the individual wires in the screen.)

Do keep in mind, though, that anything even approaching a room-sized faraday cage is likely to only be a partial shield unless it is carefully and professionally designed and maintained, something that is completely impractical for most individuals. A partial shield, though, can often reduce electromagnetic signals from the outside by a critical amount. When I was working at a broadcast transmitter site that had an unacceptable level of electromagnetic radiation from the FM broadcast antenna into the area at ground level where the vehicle was commonly parked, I had a carport built with copper screen imbedded into the roof of the carport. The reduction in electromagnetic radiation beneath the carport was quite dramatic -- as actually measured using professional equipment. Since nuclear EMP comes in from a fairly high angle, it is likely that a similar arrangement, but using aluminum screen, would reduce the EMP substantially, possibly enough to protect vehicles and other large items stored below the shielded structure. In the case of the carport that I had built, I grounded the imbedded screen because I knew that the wire leading to ground would not act as more of an antenna than a ground for the shield. (I also knew that the ground at the bottom of the carport was an extremely well-designed grounding system.) Although most small faraday cages should not be grounded because of the "accidental antenna" problem, if a carport shield can be well-grounded at all four corners, then a direct wire going to a ground rod at each corner might be a good idea.

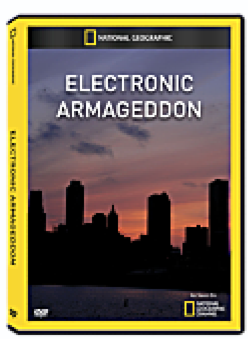
One question that most people don't think about is how to test the shielding efficiency that you are using. Most people don't have access to professional electromagnetic field measuring equipment, and they certainly don't have any nuclear weapons laying around the house. The most damaging part of a nuclear EMP has frequency components that run roughly from the AM broadcast band to the FM broadcast band. The components that are most likely to damage ordinary small electronic items are near the FM broadcast band. Therefore, you can make a rough test of your shielding effectiveness by tuning a radio to a strong FM station and see if your shielding silences the radio so that you can't receive the FM station. You can try the same thing with AM. In general, the good electrical conductors like copper or aluminum will be better at shielding the higher frequencies in the FM range, while steel shielding may perform better in the lower-frequency AM band. The AM and FM reception test is an imperfect test, but it will give you some valuable information; and it is the only thing available at any reasonable cost to most people. The closer that you can get to a high-power broadcast transmitter site, the better this test will be.

The radio test is often poorly done and misunderstood by non-engineers. Most EMP engineers don't like the radio test because it is so much less accurate than tests using tens of thousands of dollars worth of equipment. Such professional tests are enormously out of the reach of the average person. I will probably have a separate page explaining more details of the radio test that will be online later. In watching many videos on YouTube of people doing the radio test, I found that nearly everyone was misinterpreting the results. Two people who were doing it right were Arthur T. Bradley (who has a Ph.D. in engineering) and another person who did his AM test standing outside the fence of a 50,000 watt AM transmitting antenna. (Not everyone needs to be near a major transmitting antenna, but you do need to have a very strong AM and FM signal. Tests using cell phones and UHF two-way radios can be misleading.)

It is important to have all of the computer data that is important to you backed up onto ***optical*** media, like CD or DVD. Paper printouts are fine, but after an EMP attack, most of the data on paper printouts will simply never get typed back into computers, so those paper printouts will just become your personal mementos.

CD and DVD data (in other words, *optical media*) is not affected by EMP. Even if your computers are destroyed, if the country's economy can get re-built after an EMP attack, then new computers can be purchased from other continents. If all the computer data is gone, then recovery is going to be many years later than it would be if the data could just be reloaded from optical media. Computer data runs our modern world. It is a major part of the invisible magic that I mentioned at the top of this page. If you own a small business, that computer data can be especially important. (It is probably not a good idea to use double-sided DVDs, though, since there is the remote possibility of arcing between layers during electronic attacks. It is best to just use single-sided single-layer media.) For long-term storage of data, ***archival grade*** CD-R and DVD-R media are available at a reasonable price from manufacturers such as Verbatim and Memorex. The archival grade media are much more likely to last for many years or decades, and they don't cost that much more than standard media. Most stores don't carry archival grade media, but they aren't that difficult to find, especially on larger electronics stores on the internet.

An even more rugged type of recordable DVD is the M-Disc. The M-Disc has been tested by the U.S. Navy environmental laboratories and is estimated to last for centuries. The M-Disc requires a special laser for recording, but a number of DVD recorders for computers, selling for as little as 30 U.S. dollars, have been certified to work with the M-Disc. LG Electronics makes most of these M-Disc ready DVD burners. Once recorded, they will play on just about any DVD playback device. The M-Disc DVD can be used for almost any kinds of files that can be stored on a computer.



National Geographic EMP
Documentary DVD

Protecting most of the electronic appliances in your house against EMP, if they are plugged in and in use, is probably hopeless (unless your home is an effective faraday cage and you have the proper filters and fast surge suppressors on the incoming power line). There is always the possibility, though, that you will be near the edge of an area that is affected by an EMP attack. For this possibility, the combination of ordinary surge suppressors and ferrite suppression cores could be very valuable.

Ferrite suppression cores are those imbedded cylindrical things that make the cylindrical protrusion in the power cords on sensitive electronics equipment. They can be very effective to protect your equipment against ordinary transients --such as the type that occur constantly on the power lines and slowly damage your electronics equipment. The ferrite suppressors on power cords (and inside of many surge protectors) are usually the common type 43 ferrite material, which offers a considerable amount of protection against ordinary transients, but would do only a little to protect against the very fast E1 component of a nuclear EMP. You can buy separate snap-on ferrite suppressors, including snap-on ferrite suppression cores with type 61 ferrite, which will absorb much faster pulses. The ferrite cores with material 61 don't cost all that much more than the older ferrite, and they should attenuate the spike from a nuclear EMP much better than type 43 material. If you're in an area where there is a strong EMP, it won't attenuate it enough to do any good at all, but if you're at the edge of the affected area, or just get a nearby lightning strike, or have a lot of ordinary voltage spikes on your power line, these snap-on ferrite cores with material 61 could be extremely valuable. They are sold by companies such as Mouser Electronics. Look for items such as Fair-Rite part number 0461167281 or 0461164281.

Items like surge suppressors and ferrite suppression cores are only going to be effective against relatively small pulses that come in through the power line. A large EMP will totally and completely fry your large screen television by directly inducing currents in the equipment itself that are far too large for it to handle. The same is true for much of the other electronics in your home. There is no reason to assume, though, that any EMP attack will be maximally effective -- or that you will never be right at the edge of the affected area. Also, even if an EMP attack never happens, an endless barrage of small voltage spikes is eating away at your electronics equipment every day unless you are doing something to protect against it.

There are all kinds of EMP attack scenarios. There are many situations one can imagine where the area around the edges of the EMP zone is extremely large. There could be entire large cities where even the unshielded equipment with minimal protection mostly survives, but everything unprotected is fried.

There is actually quite a lot that can be done to protect your electronics from a small EMP attack or if you happen to be at the edge of the EMP-affected area. If you live in a lightning-prone area, many of these things will give your electronics equipment a much longer lifetime. Repeated hits from small electrical transients is a major cause of electronic failures, ranking second only to heat as a cause of most types of electronic failure.

It is important to read the EMP Commission Report on Critical National Infrastructures, so you'll have some idea of the scope of the EMP problem. Note: This is a 200-page report (7 megabytes), and could take a half-hour or more to download if you are on a slow dial-up connection.

This EMP Commission report is the best information, but definitely not the last word, on likely EMP effects on today's infrastructure and equipment. The EMP Commission relied heavily on data from simulators, and this data does not explain all of the effects that were actually seen in the 1962 nuclear tests, especially in the Soviet EMP tests over Kazakhstan.

One thing that you'll discover in that Critical National Infrastructures Report is that automobiles and trucks seem to be more resilient against EMP attacks that what is portrayed in most fiction. Although many vehicles would be rendered inoperative, and it will be a regular "demolition derby" on streets and highways, many (but not all) vehicles that are *not running at the time of an EMP* will be likely to run after they are started (although there is a very high probability that your car will experience electronic damage outside of the electronic ignition system, and your car may have to be started in an unconventional way. It is also possible that you may have to momentarily disconnect the battery so that electronic modules can recover from an EMP-caused latch-up condition, a situation that, in automobiles, is unique to EMP.) It may be necessary to have a maintenance manual for your car so that you, or someone you know, can figure out how to bypass the damaged modules in your car.

Vehicles, especially gasoline vehicles, have to have a robust amount of electromagnetic shielding around the entire electronic ignition system. Otherwise, the ignition noise from all the automobiles would render radio and television sets unusable (especially car radios). Today's automobiles have published standards for electromagnetic shielding, but there is not much consistency in shielding requirements. You can check this list from Clemson University for a partial list of the many and varied standards for electromagnetic shielding of automobiles. These numerous different automobile standards are one reason why all conclusive statements about vehicular EMP sensitivity cannot be believed.

The EMP Commission tests on vehicles was done on vehicles made in 2003 and earlier. Since then, the number of microprocessors controlling vital functions in automobiles has increased dramatically. So very recent models, which contain up to 100 microprocessors, may be dramatically more sensitive to EMP than the vehicles tested by the EMP Commission.

Some additional information on vehicles may be found on the EMP Effects on Vehicles Page.

The most difficult part of operating a car after an EMP event (or even a solar superstorm or a cyber-attack on the power grid) is likely to be obtaining gasoline. It is very foolish to ever let the level of fuel in your tank get below half full. In a wide range of emergencies, one of the most valuable things to have is a full tank of gasoline. A solar superstorm will NOT damage your automobile; but by knocking out the power grid, it can make fuel almost impossible to find for a very long time. (Florida requires standby generators at gasoline stations, but most other places do not have standby power at gasoline stations.)

It is important to remember that the last time an automobile was actually tested against nuclear EMP was in 1962. Everything since then has been in simulators that we hope are close to the real thing.

One common question people ask is about grounding the frames of cars. In most situations, attempts to ground the frame of a car are more likely to just make matters *worse* by providing an accidental antenna for EMP. The safest way to provide a modest amount of EMP protection for a car is to keep it parked inside a metal shed.

Retrofitting an automobile to make it EMP-resistant is a project that would be too difficult and expensive for most people. For those who want to try, the only authoritative document that I know to be available is one called "EMP Mitigation - Protecting Land Mobile Vehicles from HEMP Threat Environment" which was published in March, 2011. To find this document, go to the Protection Technology Group page, then click on the Media Library link at the top of the page, then go to the White Papers link. Scroll down on the White Papers page until you get to the article that you want. The article specifically applies to military vehicles, but has relevance to commercial vehicles as well. Note that the part of the referenced article that refers to bonding of "all metallic structures to a single point ground system" is referring to an electrical chassis ground on the vehicle, not to an earth ground.

(I'm not giving a direct internal link to that page on protection of vehicles because the Protection Technology Group has been making extensive changes to its web site in recent months, and the exact location of the article on their site may change.)

I highly recommend any of the articles on the Protection Technology Group White Papers on their Media Library page as an excellent source of information about

EMP and/or lightning protection.

In the 1962 Soviet high-altitude nuclear tests over Kazakhstan, even military diesel generators were damaged. This process was apparently started by a large voltage spike from the fast E1 component of the pulse punching through the insulation on the wiring at a single point in the generator windings. According to Vladimir M. Loborev, one of the chief scientists who studied this phenomenon, "The matter of this phenomenon is that the electrical puncture occurs at the weak point of a system. Next, the heat puncture is developed at that point, under the action of the power voltage; as a result, the electrical power source is put out of action very often." (From his report at the 1994 EUROEM Conference in Bordeaux, France.)

This should be a warning to anyone who is planning to use any very old vehicle for possible use after an EMP event. If you have a pre-electronic-ignition era vehicle, it is important that you also have an electrical wiring diagram for the vehicle, and plenty of fuses (and I do mean plenty of fuses) and some critical electrical spare parts. My own personal experience in maintaining a 1959 model RCA high-power television transmitter until the year 2000 tells me that it is very easy for high voltages to punch through old insulation. Although post-EMP repair of these older vehicles may be easier than repair of a modern vehicle, it can be very frustrating, since very old insulation on electrical wiring can become extremely brittle.

To protect small portable generators from the kind of insulation puncture in the windings that was experienced in the 1962 Soviet tests, it is likely that simple MOV transient protectors (wired across one of the 120-volt outlets) on most generators would provide sufficient protection. The MOVs may not be fast enough to capture the leading edge of the EMP spike (due to wire length), but it takes a lot more energy to punch through enamel insulation than to damage microelectronics, so it is very likely that these MOVs would provide adequate protection for the insulation. Small MOVs are readily available from companies such as Radio Shack (part number 276-568). (It is unlikely that these MOVs would be adequate to protect any microelectronics that may be in the generator, though, unless they are carefully wired to minimize lead length.)

(Actually, in most MOVs, the basic MOV reaction time is fast enough for nuclear EMP. The problem with MOV speed often has to do with how they are usually installed. If the leads of the MOV are kept very short and straight, the device may be fast enough to protect microelectronics from any EMP.)

If you are constructing any kind of EMP protection that does need a ground connection, make sure that it is an extremely good-quality ground. If the soil is dry, rocky, or otherwise likely to be of poor conductivity, proprietary commercial grounding compounds are available to enhance the conductivity of your ground rod to the earth.

Bentonite is a material that is widely used in drilling industries that can also greatly enhance conductivity between the grounding system and the earth. I have found bentonite to be *very* effective as a grounding material. For most people, bentonite is easier to obtain and much more practical than the proprietary commercial grounding compounds. If it is not feasible to bury a ground rod vertically, a fairly good ground can be made by digging a trench as long and deep as is feasible, then placing flexible copper tubing (such as is used in plumbing) in the trench, covering the copper tubing with bentonite or other grounding compound, covering with topsoil, then using the above-ground part of the copper tubing for the ground connection. (I have done a lot of grounding, and I have never in my entire career pounded a grounding rod into hard or rocky soil. That is an exercise in futility. Either drill a hole for the grounding rod so that you can surround it with bentonite or grounding compound, or use a long horizontal trench.)

I have the first draft on-line now of a separate page on this web site about grounding for EMP, and how to construct a ground that is likely to avoid the "accidental antenna" problem that is so common when non-engineers try to construct an electrical ground for EMP. It is good to ground an electromagnetic shield if you know how to do it, but most people just make the problem much worse with a very badly constructed ground. If you think that a water pipe or the ground wire on an AC outlet is a good ground for EMP, then you should definitely forget about grounding. Neither of these connections is anything close to being an effective EMP ground. Also, any time that you are thinking of running a long unshielded wire from a "faraday cage" to a ground connection, don't do it. The long wire will simply function as an antenna.

Steel enclosures of various kinds are often suggested for use as an EMP shield for storing electronics equipment. Although steel can be a good electromagnetic shield for lower-frequency components, I have found it to be considerably inferior to better electrical conductors such as copper and aluminum in actual measurements in intense electromagnetic environments. Steel has *different* characteristics from better electric conductors such as copper and aluminum, so the best situation if you are using an steel enclosure is to add a layer of copper or aluminum screen or foil as an additional layer of shielding. (Steel tends to be better at shielding lower frequency components, but aluminum and copper are better at shielding the higher frequency components that are more likely to damage smaller items.) Actually, there is evidence that the very best EMP shields would be alternating layers of steel and aluminum or copper, with an insulating material separating the layers of metal. (This is how some of the best electromagnetically shielded buildings are actually constructed.) The main problem with consumer steel enclosures is that they are usually painted to resist corrosion, and the paint is an electrical insulator that keeps the steel from really electrically surrounding the objects inside. This is why a galvanized garbage can with a lid works fairly well as an EMP shield, but a painted steel cabinet provides only minimal protection. A properly constructed faraday shield made from stainless steel can be very effective.

One very effective means for isolating disturbances on the power line from electronics equipment is the use of a "double-conversion" type of "true online" UPS (uninterruptable power supply). Any very large E1 pulse coming in on the power line would destroy the UPS, but the UPS would have isolated the equipment from the power line transient before failing. It is important to note that most uninterruptable power supplies on the market are NOT the "true online" type, and are of very limited usefulness for isolating the equipment from the power line (even for ordinary voltage spikes). Most inexpensive uninterruptable power supplies let much of the voltage spike hit the equipment before switching to internal battery power after the AC line power has failed.

The best of the small true online UPS units are those made by SOLA, but they are also rather expensive. Tripp-Lite makes a series of true-online double-conversion UPS units that are less expensive and are easier to for most people to find. (Many major UPS manufacturers have been rather deceptive in the past about whether their UPS units are actually the true-online double-conversion type, although most companies are becoming more honest about the architecture of their UPS units since the difference in actual equipment protection is quite considerable.)

The true online UPS units can also isolate equipment from the effects of the solar-storm-like E3 pulse or the effects of an actual solar superstorm. Although the principal effects of E3-type events for the individual is total loss of power from the power grid, these events could cause extreme distortions in the AC power waveform for a short amount of time until the grid collapses. This extremely-distorted AC could burn out motors and damage electrical and electronics equipment in a very short amount of time unless measures are taken to isolate the equipment from the power line by using a true online UPS or a ferro-resonant transformer. Certain types of ferro-resonant transformers, such as the SOLA CVS series, can isolate equipment from power line distortions by insuring that the equipment gets either a pure sine wave or nothing at all. The SOLA CVS transformers are also extremely effective at blocking most voltage transients from getting into equipment, although they won't completely block extremely large and fast transients such as those from the fast E1 component of a nuclear EMP.

One very important consideration for anyone using a UPS or a ferro-resonant transformer for protection any equipment containing a motor of any size (even a refrigerator) is that motors have very high start-up currents, and neither UPS units nor ferro-resonant transformers are designed for motor operation. If you are trying to use either a UPS or a ferro-resonant transformer to protect any appliance where a motor is a significant part of the load, you have to select a UPS or ferro-resonant transformer that has several times the rated load of the appliance.

Because electronics equipment is becoming more vulnerable to voltage transients all the time, the surge suppressors that are sold for protecting expensive consumer electronics are getting better all the time. Today's consumer AC plug-in transient suppressors are much faster than those sold just a two or three years ago, and many of the newer units will absorb much larger voltage spikes. Although none of the consumer-type surge protection devices are likely to be completely effective against EMP, they may be helpful in protecting some types of household appliances.

If you have a small business with too much critical data to routinely back up onto optical media, you should consider looking for a data center with EMP protection and plenty of backup power. Many data centers are actually quite fragile, and many have proven to lack even the ability to survive a severe rain storm. Some data centers, though, occupy former military facilities and claim to be EMP-hardened. You may want to consider backup data centers such as Infobunker and Cyberbunker. Just within the past two or three years, many additional commercial data centers have taken steps to become EMP-protected.

Those who trust in the inherently fraudulent concept of "cloud computing" will find that, after a major electromagnetic disturbance, the "cloud" will have dissipated into the clear skies. When you send your data away into a mystical "cloud," it actually goes onto real servers; and the vast majority of them are much more fragile than the computing industry will admit; and this fragility has been repeatedly proven by real-world failures. "Cloud computing" can be very useful and economical for many applications, but you must be very aware of its fragility. Fortunately, competitive pressures have recently forced many data storage providers into taking serious measures to reduce this level of fragility.

For anyone with two-way radio equipment or radio receivers that are already extremely well-shielded and also well isolated from the power line, but left with the vulnerability of a connection to an external antenna, EMP protection devices can be obtained that are made by Polyphaser. The Polyphaser EMP protection devices for antenna connections generally use only type N connectors (so you may need an adapter), and the cost is generally about $125. Polyphaser does not sell these devices directly to the customer in small quantities, but they can be purchased through some specialty electronics retailers if you know *exactly* what model number of Polyphaser device that you want.

For conveniently protecting small electronics, such as laptop computers, when they are not in use, an aluminum briefcase should potentially be very useful, but there are large differences in the shielding ability among different metallic briefcases. First, the briefcase needs to be a solid metal aluminum briefcase (not the less expensive "aluminum briefcase" that is actually made largely of aluminum-colored plastic). (The aluminum-colored plastic briefcases are completely useless as an EMP shield unless a considerable amount of additional electromagnetic shielding is added.) If you are unsure of the electromagnetic integrity of your aluminum briefcase, a layer of electromagnetically shielding metallic spray paint can be added to the exterior of the briefcase. The cans of electromagnetically shielding spray paint tend to be rather expensive, but they can be purchased from companies such as Mouser Electronics. For real effectiveness, a good electrical contact between the two halves of the briefcase is critical, especially at the hinges and the latches. A well-shielded briefcase should be able to completely eliminate reception of an FM radio receiver that is tuned to a strong FM station and placed inside the briefcase with the latches secured. Repeat the test with an AM station.

Many lessons about what to expect after an electromagnetic event can be learned from the aftermath of the March 2011 tsunami in Japan. Unfortunately, the information about these events after the initial earthquake and tsunami by the news media in the United States has ranged from horrible to non-existent. Nearly all of the deaths and suffering after the first hour of the tsunami have been due to the absence of electricity and electronic communications. Just about the only place to get accurate information about the aftermath of the tsunami has been from NHK World. NHK has shown things like what happens when you try to open the grocery stores after power is restored after a prolonged outage, and the difficulties of supplying the grocery stores from the food warehouses when the inventory control and computerized ordering systems are not working.

It should also be noted that the problems experienced in Japan by certain nuclear power plants are likely to be serious problems for any country in the aftermath of a severe solar storm or nuclear EMP. This has been discussed in connection with EMP long before the tsunami in Japan. Nuclear reactors require a reliable external source of electricity for cooling systems after any sort of scram shutdown. All nuclear power plants have on-site (usually diesel) standby generators with a short term fuel supply. In the United States, the Nuclear Regulatory Commission finally decided to formally address the issue of a very long term power outage in December 2012. The proposed new rules will take some time to formulate and enact into law, but the NRC report contains a very valuable and comprehensive summary of the danger.

It is important to remember that ionizing radiation from a high-altitude nuclear EMP detonation will not reach ground level (unless, of course, the weapon fails to reach "high-altitude.") The following information is included because of the possibility of an electromagnetic event leading to a nuclear power plant accident (and because I've been frequently asked about it).

For any type of moderately large radioisotope exposure, there are basically three ways to reduce the medical impact of the exposure. One method is with a chelating agent. Chelating agents bind to the radioactive element and aid in its excretion from the body. Chelating agents also bind to a broad range of chemically similar elements in addition to the radioactive substance that you are targeting, including elements that are necessary for human life. Chelating agents should generally not be taken continuously for any long period of time because they will cause deficiencies of important mineral nutrients if they are taken continuously for too long.

The second way of overcoming a radioisotope exposure is to consume a large amount of a stable (non-radioactive) isotope of the element being targeted. The most common use of this method is the use of stable iodine to block the body's absorption of radioactive iodine by taking large doses of stable iodine, usually in the form of potassium iodide. This general method can be extended to minimize the absorption of other radioisotopes as well, but you have to use the right elements to target the right radioisotopes.

The third way of minimizing damage by radiation is to consume powerful antioxidant mixtures. Except for neutron radiation, ionizing radiation (alpha, beta and gamma radiation and X-rays) causes biological damage through oxidation damage. Animal studies have shown certain combinations of common nutritional antioxidants to be very effective in minimizing radiation damage. Single antioxidants do not work nearly as well as well-formulated combinations of antioxidants. In the separate page on antioxidants for radiation, there is information about the combination of nutrients that have good evidence of being very helpful in cases of radiation exposure (and that are readily available in many countries).

In the event of a nearby nuclear power plant meltdown (or the much more likely danger caused by overheating of spent fuel rods in unprotected cooling ponds), there are three radioisotopes that pose most of the danger to humans. One is radioactive iodine, which is easily taken up by the thyroid gland. Potassium iodide tablets are readily available that can saturate the body with iodine and prevent most of the absorption of radioactive iodine in the human body. Radioactive iodine decays very quickly, so this should not be a long term problem.

Another radioisotope is cesium-137 (as well as cesium-134, which has a much shorter half-life and is generally produced in much smaller quantities).

The standard antidote for radioactive isotopes of cesium is pharmaceutical grade Prussian Blue. (Do ***not*** use any kind of Prussian Blue that is not made for human consumption, or you are likely to just make yourself sicker.) The United States, and most other major countries, maintain stockpiles of pharmaceutical grade Prussian Blue. In the United States, these stockpiles are deployed at various sites across the country. Nevertheless, the doses of Prussian Blue are unlikely to reach individuals before they have already absorbed a significant dose of radioactive cesium.

An alternative antidote for radioactive cesium is potassium. A healthy human body will try to tightly regulate its internal levels of potassium. If potassium levels are not saturated in the presence of radioactive cesium, the human body will try to absorb the cesium instead. Although potassium is a common element in the human diet, ***taking too much potassium can be dangerous***, or ***even fatal***. A potassium intake that overloads the body's regulatory system can result in heart rhythm problems that can be fatal. This is the reason that, in the United States, the Food and Drug Administration limits the amount of potassium that can be sold in most over-the-counter supplements to no more than 99 mg. per capsule. Timed-release potassium tablets are available by prescription in larger doses. The prescription timed-release tablets release potassium slowly over time to prevent a dangerous potassium overload. One simple way to saturate your body with potassium with very little risk of potassium overload is by eating bananas. Bananas have a large amount of potassium (as do several other foods), but the human digestive system cannot absorb the potassium from bananas too rapidly. So potassium overload from bananas is very rare. (It is true that all bananas are naturally slightly radioactive, but if there is a lot of radioactive cesium in the environment, the very tiny amount of radiation from bananas is the least of your problems.)

In any kind of nuclear event (or any event where the electric power grid is down in an advanced country), you are unlikely to be able to go to the store to purchase bananas. If the power is out over very large areas, then buying any kind of food in most advanced countries is likely to become quite impossible. Fortunately, freeze-dried banana slices in cans are readily available from nearly any company that sells freeze-dried foods for long-term storage. The thickly-cut freeze-dried banana slices maintain their taste quite well. (In fact, you may have difficulty in resisting the temptation to simply consume them as a snack.) Consider keeping some freeze-dried bananas in your long-term food storage.

The third radioisotope that is a significant problem after severe reactor accidents is strontium-90. Strontium-90 is not generally as widely dispersed in reactor accidents as it is from nuclear weapons detonations within the lower atmosphere. Strontium-90 can be particularly dangerous, though, since it is likely to be taken up by the bone, where it can remain in the body for extremely long periods of time. The absorption of strontium-90 can be limited by taking adequate calcium. The human body has difficulty distinguishing between calcium and strontium, and is more likely to absorb strontium-90 when there is an inadequate amount of calcium in the body.

Another way of limiting the absorption of strontium-90 is by taking natural (non-radioactive) strontium. In the United States, and some other countries, natural strontium is available as a nutritional supplement, usually as strontium citrate. In many other countries, strontium is available as a prescription medicine in the form of strontium ranelate. Both the nutritional supplement and the prescription medicine containing strontium are used to strengthen bones. Human bone that has some of the calcium replaced by natural strontium has been shown to be significantly more fracture resistant that bone that contains only calcium.

(Although the subject is outside the scope of the material on this page: for the unknown radioisotopes that may be present in a "dirty bomb" detonated at ground level, the antioxidant mix may be the best medical defense. The same can be said for the detonation of a salted bomb (such as a cobalt bomb), which could be produced by a country intending for the weapon to be used by terrorists at ground level. A salted bomb would not be a militarily useful weapon, but could be easily built by a nation intending to use it as a terrorist weapon simply by constructing a simple fission bomb with a cobalt-alloy tamper or otherwise adding ordinary cobalt to the interior of the bomb. When such a bomb is detonated, the neutron radiation would convert much of the ordinary cobalt into cobalt-60, a gamma emitter.)

For more information on health matters related to radiation, see the Radiation Emergencies - Health Effects and Treatments page at the U.S. Centers for Disease Control and Prevention.

The aftermath of the 2011 tornados in the United States has exposed the vulnerability of the cellular telephone system. Most cell phones are too small to intercept enough EMP to damage them; but the cellular repeaters, which are necessary to the operation of the cellular telephone system, are very vulnerable in a wide range of disaster situations. Unfortunately, the cellular telephone system was not designed with any peer-to-peer (direct cell-phone-to-cell-phone) capability. This means that if the cellular repeater stations go down, your working cell phone becomes useless. Some large companies are now actively working on solutions to this peer-to-peer communications problem.

A system for direct peer-to-peer communications is now available on some cellular phone that is known as LTE Direct. The LTE direct mode generally has a range of about 500 meters. This direct cell-phone to cell-phone mode will, of course, work even when the cellular repeaters are all down. There are preliminary plans to make LTE Direct, or a similar system, a standard item in the upcoming 5G cellular system that will begin to be phased in about 2020.

Some cellular telephone companies have developed mobile repeater stations for use in disaster situations. These have proven themselves, so far, to be mostly for show, and quite inadequate in any real-life large-scale emergency situation. Although these mobile cellular repeaters work quite well, there just aren't enough of them, and they can't get to the proper locations fast enough.

Your personal EMP and solar storm protection plan is likely to be very different depending upon where you live, and how many other people live with you. The only way to make an effective plan is to try to imagine an unpleasant future where you are suddenly thrust back into the middle ages. One thing that an EMP or a severe solar storm won't destroy is the knowledge of how to re-build effectively. Hopefully, even if we don't get an robust and permanent infrastructure built in time to prevent a catastrophe, the rebuilt post-pulse electrical and electronic infrastructure will be something that is permanent, and that all of us can finally trust, unlike the very fragile infrastructure that we have today.

Other EMP pages at this web site:

- For a general introduction, see the Futurescience Main EMP page.
- There is a comprehensive and well-referenced page at this site with extensive details about the 1962 Soviet nuclear EMP tests over Kazakhstan, which resulted in extensive damage to the electrical and communications infrastructure.
- There is a separate page with additional details about EMP effects on motor vehicles.
- Notes and Technical References on Nuclear Electromagnetic Pulse (and on solar storms).
- Also see my article about the Operation Fishbowl series of high-altitude nuclear tests by the United States in 1962 over the mid-Pacific. That article includes extensive references -- and a video of the Bluegill Prime disaster.
- There is also a heavily-referenced page about General EMP History, including details on the balloon-launched Hardtack-Yucca nuclear test. A link to the video of the helium-balloon-launched nuclear weapon is included.
- Another page on EMP explains the critical difference between the E1, E2 and E3 components of nuclear EMP.
- Also at this site, there is a ***very important*** page on common EMP Myths.

Jerry Emanuelson's email address on EMP-related matters is emp@futurescience.com. I am glad to answer brief questions on this subject, and email from readers is very valuable in helping me to improve this web site; but please don't be one of those people who sends me pages of questions and expects me to spend hours answering them for free. (I actually do get email like that.) Also, please be aware of the fact that more than half of all the email that I get regarding my rather large web site consists of questions that are already answered on the pages of the web site. I know that there is a lot of material to go through on this web site, but please try to read through the parts that seem to be relevant to your questions before emailing me. And please be patient since my web sites cover much more than just EMP, and I am constantly buried in email.

One of the major problems that I have been having over the past few years is the number of people sending me "one quick question" which requires a long and complicated answer. For this reason, I have been running several weeks behind in answering most of my email.

If you have numerous questions regarding EMP and your personal situation, I am available for individual consulting via email and phone on a flat fee per hour basis. Whether you want to purchase an hour of my time or several hours, I am pretty good at understanding individual situations using email and/or phone and suggesting possible solutions and answers. I was raised on a farm, but spent most of my life living in a city. My career has been spent working in production factories as well as on isolated mountaintops in the Rocky Mountains. So I have a good understanding of a wide range of situations.

For additional information on preparedness, especially as it relates to electromagnetic pulse, there were a special series of excellent internet radio programs on the subject produced by EMPactAmerica in September, 2011. Those radio programs are available free at http://www.empactradio.org.

Site Map of all of the Futurescience EMP Pages