BUILDING EMP FARADAY CAGES THAT WORK

J. T. Smith – Sept 30, 2014

1.0 Consequences Of An EMP Attack On America

Life as we know it in America could end in seconds if an enemy were to launch and detonate a nuclear weapon high over the center of our country. It is estimated that a successful high level electromagnetic pulse (HEMP) attack could be a million times more devastating than the 9/11 attack and could literally decimate America. It would fry the nation's electrical grid and the circuitry that powers our homes, businesses, hospitals, phones, cars, planes, traffic lights, ATMs, water supplies, and anything else not "hardened" against such attacks. Dr. William R. Graham, former science advisor to President Ronald Reagan and chairman of: "The COMMISSION TO ASSESS THE THREAT TO THE UNITED STATES FROM ELECTROMAGNETIC PULSE (EMP) ATTACK", testified to congress that, within just one year of an attack, 70 to 90 percent of Americans would be dead from starvation, disease or from freezing to death and our civilization would be set back at least to the 1800s.

Following an event of this type, life could become even more difficult than it was for those living in the 1800s. During that time most people lived on or near farms, and had horses for working their farms, to produce their own food and provide transportation. They had their own water and fuel sources nearby, made their own clothing and were generally independent and self sufficient.
Today we have a population tens of times larger which cannot be sustained without electricity and municipal services. Most now live in cities many miles from food, water and fuel sources. Our computers and microchips control our vehicles, trains and airplanes most of which would become inoperable. Much of our food (35%) is imported. Nearly all is shipped long distances. Today only about 2 % of the U.S. population is producing food but nearly all of these depend on large farm/transport/processing equipments requiring electricity or on fuel which must be pumped by electricity. Even if some food could be produced, most of it would perish since it could not be dried, refrigerated, processed nor transported. Without electricity nobody could go to work. Manufacturing plants and businesses would be closed. The stock market and bank transactions and records could be lost since this information, as well as backup copies, are stored electronically.

1.1 National Recovery Following An EMP Event

Recovery from an EMP attack could be very slow. There are 1000s of transformers in the power grid, with about 300 being critical. Most of the critical ones have no spare or backup parts. They are not manufactured in the U.S. and some have an order wait time from one-to-three years. Also, our civilization has become very inter-dependent. In order to make repairs on the power grid for example, there is a need for telecommunications, but telecommunications requires the power grid to work. The financial network must operate to maintain the economy; we need the transportation system, roads, street lights, and control systems, to operate just to get people to the failed power, telecommunication and other systems. Without the existing infrastructure, the military would also find it difficult to operate even though some of the military equipments have been hardened against EMP events.

1.2 The Cost Of EMP Shielding

Shielding to protect the electrical grid against EMP is a relative inexpensive. As noted in the Newsmax story "EMP Attack Could Wipe out U.S.," the 300 transformers that are critical to the power grid could be protected for $200 million to $400 million. Yet, very few power companies, banks, stock brokerage firms, or other industries have seen fit to shield their facilities against an EMP strike. Acknowledgment should be given to the KSL television station in Salt Lake City and to another station in Provo, Utah who has taken action to harden their facilities sufficiently to withstand an EMP attack.

1.3 Shielding Of Personnel Equipment

The ideal situation would be to have the entire house shielded and this can be done to a degree, see the book "EMP Protecting Family, Homes, And Community" by Don White and Jerry Emanuelson. The cost of doing this for an existing home however, is at least as much as the cost of the home. For this reason, the goal must be to identify and shield all critical piece of equipment considered essential for one's survival following an EMP strike. These critical items must remain operable, no matter how intense the EMP signal is and no matter when and how it occurs. One must also have a way of knowing that the protected items will survive and must have a plan to live within the constraints imposed by the surviving critical equipment. The list of critical equipment will be different for each family but would include electronic equipment containing microchips, equipment containing discrete electronic components and equipment containing electric motor. It could include items such as communications equipment (walkie-talkie and ham radios), computers and associated storage devices containing critical information, radios, small refrigerators, solar panels and the associated controllers, electric power generators, battery chargers and inverters, motor driven power tools such as drills and saws, volt meters, food preparation tools and appliances, medical equipment, home heaters such as wood pellet stoves and compact florescent and diode light bulbs. Much of the equipment not on the survival critical list will be sacrificed. This would include items such as large refrigerators, freezers, furnaces, room heaters and fireplaces, air-conditioners, ceiling fans, large TVs and stereo equipment and possibly automobiles. Items used to charge emergency backup batteries would need to be connected and in operation maintaining the batteries at the time of the EMP. These also would be sacrificed. While not every piece of equipment can be shielded, the key electrical parts of some can often be removed and shielded. For example, the electronic control board and electric motor of a wood pellet stove could be removed and shielded and then reassembled later when needed. Solar panels and the associated controllers can be removed, stored in shielded containers, and reinstalled later following an EMP attack. Note also that not all equipment requires the same level of protection. Micro chips and diode lights for example, can be destroyed with only a few volts while the coils of larger motors typically can withstand several hundred volts.

2.0 The EMP AREA OF COVERAGE

The area of EMP coverage depends on the altitude which the detonation occurs, see Figure 1 below. Even though it can be expected that not all EMP strikes will be successful or that they will be detonated directly over our head, one should plan as though they will be.

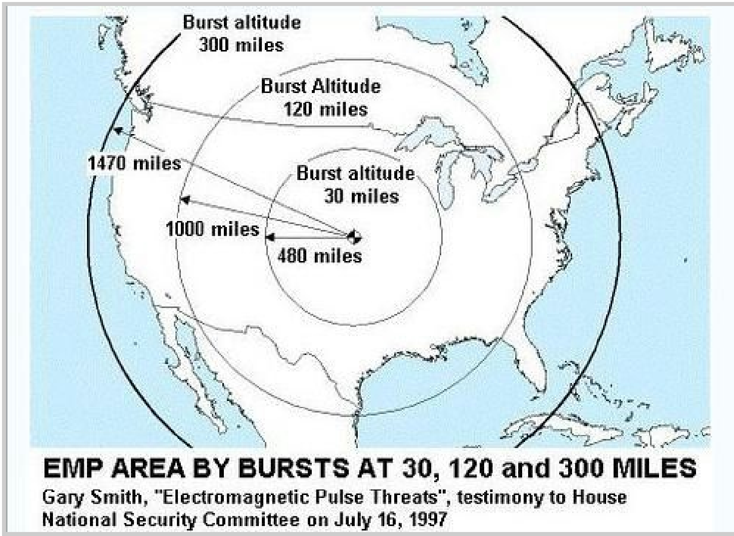

Figure 1. Blast Area Covereage as Function of Altitude

2.1 COMPOSITION OF AN HIGH ALTITUDE EMP

There are three parts to an EMP pulse. The generic waveforms for the full HEMP wave is shown below in Figure 2.using double logarithmic scales showing both the induced voltage amplitude per meter versus time in seconds.

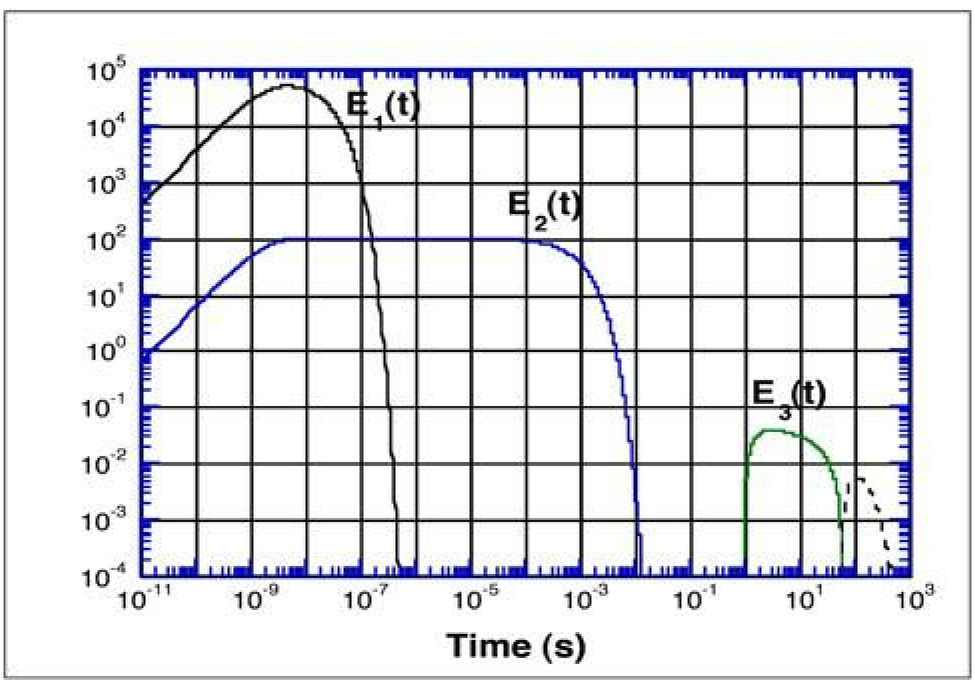

Figure 2. Three Waves of the HEMP electric field waveform in volts/meter from IEC 61000-2-9 [7].

The initial (early time) E-1 wave is what destroys electrical transmission lines, transformers, electronic and electrical equipment whether connected to the grid or not. It has the wave shape of a double exponential with an extremely fast rise time of about 5 nanoseconds, a mid-level decay time of 150 nanoseconds. It can induce up to 50,000 volts-per-meter on electrically conductive material at ground level. The initial part of the (intermediate-time) E2 wave overlaps the E1 curve and resembles a lightning strike lasting one to two seconds. It can induce about 100 volts/meter in conductive material. The (late-time) E3 wave resembles an energy surge lasting several minutes. This can affect some equipment if connected to the power grid. For more detail go to: www./futurescience.com/emp/E1-E2-E3.html

The fast rise-time of the E1 pulse, the physical length and the electrical conductivity of the target equipment determine the voltage level that could be inducted into the equipment. For example, without shielding, a simple 2 meter (6 foot) long electrical cord could receive up to 100,000 volts induced on it by such a pulse. A 4 inch cell phone could receive as much as a 5,128 volts pulse.

3.0 The Suppression Effectiveness Of Containers

To avoided destruction of one's electronic equipment due to an EMP strike requires the equipment to be stored within protective shields, i.e. containers, referred to as Faraday Cages. These shields must suppress the strength of the EMP pulse down to a level that the equipment can tolerate.

The amount of suppression of a signal is typically expressed in decibels (dB) and can be calculated by the following logarithmic equation: $SE_{dB} = 20\ Log_{10}$ (amplitude ratio) = dB. In this case the "amplitude ratio" is the amount the signal is attenuated by the container. Example: If the EMP is 50,000 volts per meter and we would like the container to reduce it inside to 5 volts per meter, then the amplitude ratio would be (50,000 v/m)/(5 v/m) = 10,000. Putting this into the equation we get: SE_{dB}=20 Log_{10}(10,000) = 80 dB of suppression required to do this.

From the table below, one can see what the induced voltage inside the container would be, based upon a 50,000 volt per meter EMP and the dB of suppression of the container. By multiplying the volts/meter, foot or inch, by the length of an item, it is possible to determine the effective voltage the item would be subjected to inside the container.

TABLE 1. DB AND VOLTAGE SUPPRESSION CALCULATIONS

dB	Amplitude Ratio	Volts/Meter	Volts/Foot	Volts/Inch
100	100,000	0.5	0.152	0.0127
90	31,623	1.58	0.482	0.0402
80	10,000	5.0	1.52	0.127
70	3,162	15.8	4.82	0.402
60	1,000	50	15.2	1.27
50	316.2	158	48.2	4.02
40	100	500	152	12.7
30	31.62	1,580	482	40.2
20	10	5,000	1,520	127
10	3.162	15,800	4,820	402
0	1	50,000	15,200	1270

The following examples use TABLE 1 in order to determine the shielding effectiveness on the interior equipment with an EMP induced signal level of 50,000 volts-per-meter.

Example #1: If a 4 inch long cell phone is placed in a container which has only 30 dB of shielding effectiveness, then the phone would receive an induced pulse voltage equal to (40.2 volts/inch) (4 inches long) = 160.8 volts. The micro chips in the phone and similar equipment are typically good up to 10 volts (per the European Union EN61000-4-3 standard) and they would be destroyed.
Example #2: If a power hand drill one foot long (with the cord wrapped around it) was placed in the same container as example #1, then it would receive a pulse equal to (482 volts/foot) (1 foot long) = 482 volts. This item would probably survive at this voltage level depending on the nature of the equipment.
Example #3: If however the drill had a cord 7 feet long and it was not wrapped around the drill and it was put into the same container as Example #1, then the cord would act as an antenna and the induced voltage would be (482 volts/foot) (7 + 1 ft) = 3,856 volts. If the insulation on the motor coils within the drill and on the cord is good up to 600 volt, then an arc could occur damaging the drill.
Example #4: If the same drill (with cord wrapped around it) is placed in the 55 gallon barrel with 76 dB suppression, the drill would see a pulse between 1.5 to 4.82 volts, well within the insulations rating and below the 120 volt operating voltage of the drill .

From the above examples, it becomes clear that equipment size, equipment type (motors vs electronic/microchips) and container suppression level must all be considered to insure protection of the equipment. If an object is placed within multiple containers, then the resulting protection is the sum of the suppression of each container. While the above examples consider EMPs of 50,000 volts/meter, several of our enemies have announced Super EMPs capable of producing 200,000 volts/meter and defeating our military.

The secure position is to choose the combination of containers which yield the highest suppression possible for the size and type of equipment.

3.1 How Electromagnetic Shields Work

The "whole" issue with shielding comes down to the size of the "hole". EMP pulse shielding requires equipment to be surrounded by a continuous electrical conducting metal container with very few if any holes. For example: A container consisting of 1 mil thick aluminum foil (i.e. the type used in the kitchen) can provide up to 94 dB suppression provide there are zero holes allowing leakage. The amount of leakage of energy into the container is primarily determined by the signal wavelength and the relative size of the holes in the shield. The sum of the size and number of holes in the shield must be hundreds of times smaller than the wavelength of the signal in order to suppress an E1 pulse sufficiently to protect the equipment inside.

This can be understood by examining the glass door of a microwave oven. The door window contains about 50 holes/inch^2. These have a diameter of about 1.2mm (i.e. 0.047 inches). TABLE 2 below indicates why visible light can easily pass through the door screen with their very short wavelength, yet very little of the longer microwave oven signal energy can get through. The same concept is true with other things as well, i.e. small grains of sand can pass through a sieve but large rocks cannot. Even using the cordless phone signal wave length which is 130 times larger than the window hole size, the microwave oven showed some leakage, reducing the signal to only one hundredth the original strength and being measured to have 40 dB suppression. At the same frequency, the metal paint can, with no holes and a very tight fitting friction lid was measured at 87 db.

TABLE 2. Effects of Hole Size and Frequency on Signal Suppression

Item	Frequency	Wave Length	Ratio of: Wave Length To Oven Hole Size
Visible Light (Violet)	789 GHz	0.38mm (0.015 inches)	0.317
Microwave oven	2.45 GHz	122.4 mm (4.8 inches)	100
Cordless Phone	1.92 GHz	156mm (6.15 inches)	130
Cell Phone	0.824GHz	364mm (14.3 inches)	330.3
F.M. Radio	1.0 MHz	300 meters (984 feet)	250,000
A.M. Radio	10 KHz	30,000 meters (98425 feet)	25,000,000

3.2 How Much Shielding Is Required?

The above shows that, in order to determine the signal suppression of a faraday cage, it is necessary to examine the effective frequency and wave length of the signals versus the size and quantity of holes which allow signal leakage. Figure 2 shows the EMP pulses in what is referred to as the "Time Domain" (i.e. the signal voltage amplitude versus time, rather than in terms of frequency and wave lengths). By using "Fourier Transforms" one can mathematically transform, i.e. convert "Time Domain" waveforms into the "Frequency Domain" consisting of a single fundamental sinusoidal frequency wave plus a series of sinusoidal harmonic frequencies having different amplitudes. Using this and other techniques, the military has determined the amount of signal shielding required in order to suppress the Fourier family of sinusoidal frequencies which produce the composite 50,000 volt/meter EMP signal. Page 20 of military specification MIL-STD-188-125 defines the **minimum dB** shielding required at different frequencies for military electronic equipment subjected to EMP interference. Non-Military electronics contain similar microchips which are just as vulnerable; therefore for commercial equipment safety it is reasonable to apply this requirement to commercial products as well.

Note that the suppression capacity of a faraday cage typically decreases by 20 dB for each increased decade of signal frequency due to the decreasing wavelength of the signal relative to the hole sizes. The military specification reflects this, by requiring an increase of 20 dB shielding per frequency decade from 1 KHz to 10 MHz. Figure 3 shows: 1) the military minimum requirement, 2) the measured dB suppression of various faraday cage configurations at a frequency of 1.92 GHz, and 3) the projected suppression levels of these cages from 1.92 GHz through 1.0 KHz.

A WARNING OF MIS-INFORMATION #1: Several persons have posted videos on the internet demonstrating their measurements of metal garbage cans when used as faraday cages. They put their AM or FM radio in their metal garbage can, closed the "tight fitting lid" and the radio stops playing. They then conclude that they have demonstrated their metal garbage can is a good

Faraday cage for EMPs. **----NOT SO!!!** Their garbage can will be worthless in protecting against the higher EMP frequencies in the range of 10 MHz to1 GHz and as result, the contents inside will be fried by any typical EMP.
Example: The place where I purchase gasoline has no walls, but it has a metal roof about 12 to 15 feet above the pumps. When I drive under the roof, my AM radio signal is suppressed and the radio stop playing just like a garbage can does when the lid is closed. Does this indicate that the roof alone could be used as a good faraday cage? ----It does suppress the low frequency radio signal in the AM radio frequency range. The dashed lines in Figure 3 shows that a Faraday cage which measures 100 dB suppression at 10 KHz, (i.e. in the A.M. radio frequency transmission range) or 60 dB suppression at 1 MHz, (i.e. in the F.M. radio frequency transmission range), will have 0.0 dB suppression at 1 GHz which is the upper frequency of the EMP signal where 80 dB suppression is required.

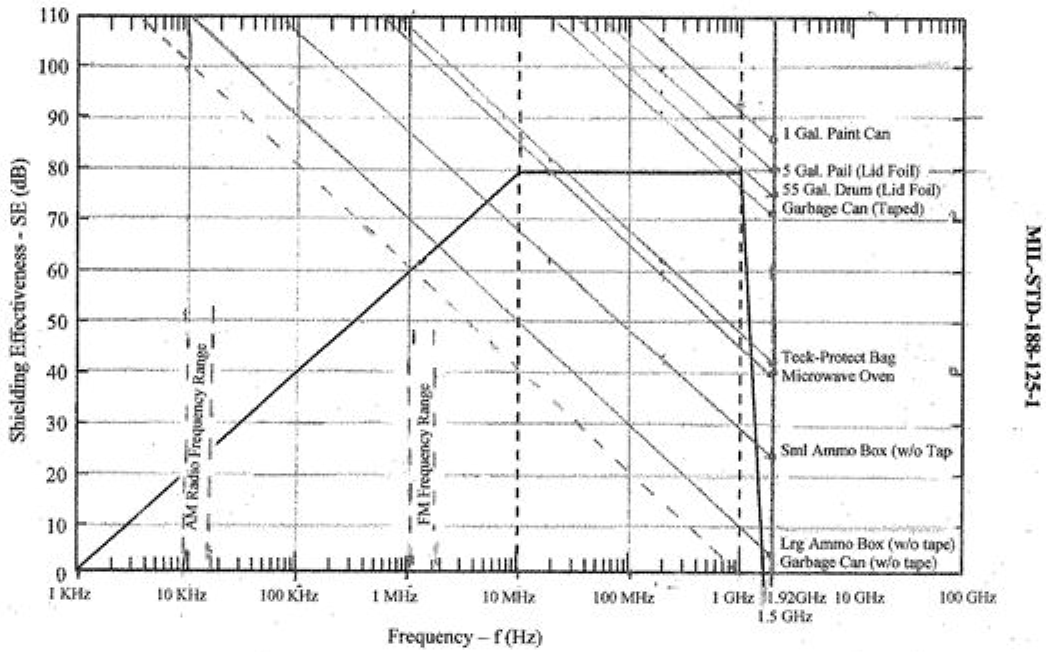

Figure 3. Measured Suppression of Containers Vs Frequency and The MIL-STD-183-125-1 Requirements

3.3 How Much Insulation Is Required Between The Container Wall And The Internal Equipment?

An EMP can induce a voltage up to 50,000 volts per meter on the walls of the container. Table 1 shows that if the container has 80 dB of shielding, then the contents inside would remain at 5 volts per meter. This is a 45,000 volt per meter difference between the two. Typically a difference of 10,000 to 30,000 volts can arc across a one inch air gap depending air pressure, particulate content and humidity. A difference of 3,000 volt can arc between two items when separated by only 0.2 inches (0.5 centimeters). Therefore the internal contents must be surrounded by anti-static or other very high-resistance materials to prevent arcing between them and the container wall. The lid need not be insulated provided there are two or more inches of space between the equipment inside and the container lid. If however, the container is filled to the top, then the metal lid must also be isolated from the contents inside. Anti-static pail and drum liners made of high or of low density polyethylene 15 to 24 mil thick and having extremely high surface resistivity of 10^{11} ohms per square (meeting MIL-B-81705-c) are available at CDF Corp. and others on the web. The 5 gallon pale inserts cost is $2 to $3 and the 55 gallon drum inserts cost $12 to $14. Unfortunately these are not sold individually, but must be purchased in quantities of 15 or more. These inserts are about an inch or two taller than the container and will need to be cut down to fit within the container and allow the lit to fit.

A WARNING OF MIS-INFORMATION #2: Nearly all Faraday cage articles on the internet indicate that the insulation between the container wall and the contents inside can consist of a simple cardboard or equivalent materials. Cardboard insulation is not much better than air, which is insufficient when one considers the high voltage differences. Also using these materials, the container floor, lid and wall coverings are separate pieces of cardboard with only air in the space between where they come together. There is no single, continuous, high-resistance anti-static barrier which encircles the equipment inside protecting it from an arc originating at the metal container surface. This arcing effect is demonstrated by the shock one receives when walking across a carpet during periods of low humidity, and reaching out for a metal door knob. In this example, the body is charged to a high voltage due to the friction of the carpet and the charge arcs to the door knob which is at a lower voltage. Electronic equipment stored with only cardboard insulation will likely be destroyed by any high voltage EMP.

4.0 Practical Considerations For Faraday Cages

1. Due to the high frequencies of the E-1 wave (10 MHz to 1.0 GHz), containers of solid metal, having virtually no holes, are required in order to achieve the required suppressing levels. Any and all holes in the metal shield must be covered with a conductive material such as aluminum foil tape. Generally: If it will hold water in any position, it will also hold out most of the EMP wave energy.
A Note About Aluminum Tape: Most aluminum tapes available in hardware stores are either too narrow, too thin and too weak or they are so sticky they are impossible to remove without the use of a razor blade or chisel. Using the wrong type can cause one to spend hours removing it before the container can be resealed. A very good tape for sealing containers is: "Ideal Seal 2000" or Ideal Seal 587A/B, from Ideal Tape Co., Inc. It is 2 ½ inches wide, strong, sticks well and comes of clean when being removed.
2. If the stored equipment is being used frequently, the containers must be easily opened and closed while reliably maintaining the level of EMP suppression. If not easily opened and closed, then tools and equipment being used on a regular basis will not end up being stored back into their protective container. This requirement is not essential for equipment being put into long-term storage.
3. Containers of different sizes and shapes are required for the different equipment, purposes and suppression level requirements.
4. Electronic equipment containing micro-chips require much more protection than do electric motors, see Table 1
5. The containers must be rugged enough that they will not become ineffective when handled roughly. This obviously eliminates aluminum-foil lined paper shoe boxes which are being promoted by some persons on the internet.
6. All items stored within the container must be electrically insulated from the containers lid, walls and bottom. This can be done by insulating the inside of the container with non-conducting anti-static material which will withstand at least 50,000 volts/meter.
7. The containers and associated liners must be readily available and inexpensive to purchase
8. It is best to not ground the containers to earth ground since grounding can appear to the EMP pulse as an antenna. Note that airplanes are metal containers having no grounding, and they are generally unaffected when struck by lightning.

4.1 Description and Evaluation of Various Container Types Used For Different Purposes

4.1.1 Easy-Access Containers Meeting MIL-STD-188-125 (Used For Protection of Micro-Chip Electronics)

One-Gallon Metal Paint Can With Standard Friction Type Lid

1-These have a measured signal suppression of 87 dB at 1.92 GHz frequency, i.e. 93 dB at 1 GHz.
2-The friction lids are easily opened with a screw driver and closed with a rubber mallet.
3- They are small but are large enough for many small electronic devices. "Imperial gallon" paint cans are several inches taller but cost about $5.
4- Their suppression should reduce the inside voltage to about one volt/meter which is sufficient for microchip electronic equipment.
5-They are rugged.
6-New paint cans are very inexpensive and are available at any paint store for $1.58 to $2.50.
7- Anti-static liner bags having high resistance are available in many sizes via the internet

Open-Top Steel 3.5 and 5-Gallon Pails With Quick-Release Lever Lock Ring/Lid

1-These provide 80 dB signal suppression at 1.92 GHz frequency, i.e. 86 dB at 1 GHz.
2-The lids are easy to remove and close.
3-They are large enough for larger electronic devices such as computers, battery chargers, inverters as well as most electric hand tools
4.-Their EMP suppression reduce the inside volts to around 2 volts/meter which is sufficient for microchip electronics
5-They are rugged
6-New open-top pails are available at most barrel supply stores and from Industrial Container Supply for about $5 to $6.
Freund Container Supply provides "black dish cover for steel pails" (part #4462) and the "lever lock ring for steel pails" (part #4446) for about $2.30 each. Note: These two parts (#4446 and #4462) are not listed in the Freund internet catalog and must be ordered by phone at 1-800-363-9822. Equivalent parts are available from www.thecarystore.com at slightly higher prices.
NOTE: Some disk cover type lids come with an O-Ring while others have a caulked type gasket. The gasket must be removed and replaced with an O-Ring made from a 3 foot long section of Latex tubing having 1/8 inch inside diameter and 1/16 inch wall thickness. This tubing is available at EVCO House of Hose for $0.92 per foot. The O-Ring must be wrapped in aluminum foil or tape, then shaped to fit the lid, and placed in it with double-back tape or other light adhesive.
7-Anti-static pail liners made of high or low density polyethylene having 15 mil thicknesses and having extremely high surface resistivity, i.e. 10^{11} Ohms/square and meeting MIL-B-81705-C, are available for $2 to $3 at CDF Corp. and others sites on the web. These liners extend above the top of the container and about 1/2 inch must be trimmed of to allow the lid to close. If the top of the container is not capped with insulation of some type, the container should not be filled beyond two inches from the top to avoid possible arcing. A cap can be made using a standard tapered plastic bucket of the same 5 gallon size and cutting off the bottom two or

three inches to form a cap. This is then inserted into a separate anti-static pail liner which is trimmed to fit the length of the plastic cap. A string is then tied to two sides of the open edge of the cap to allow its easy removal. When in place, it extends down inside the main liner providing several inches overlap of liners. If heavy sharp objects are placed in the container, it would be wise to provide plywood or similar material on the inside floor of the liner to prevent cutting thru it.

Open-Top Steel 55-Gallon Drums With Quick-Release Lever Lock Lid/Ring

1-With the rubber gasket removed from the lid, wrapped in aluminum foil and then replaced back in the lid, they provide 76 dB of suppression at 1.92 GHz frequency, i.e. 81 dB at 1 GHz.
2-The lids are easy to open and close.
3-These containers provide a convenient storage place for many larger items that are being used on a daily basis including motor driven hand tools, electronic equipment, computers, TVs, even small electric generators. They also can hold up to twenty eight 1-gallon paint cans if the additional protection is desired.
4.-Their suppression should reduce the inside voltage to around 4 volts/meter which is sufficient for microchip electronic equipment.
5-They are rugged
6-Clean used drums (including the lid and lever lack rings) in good condition and without rust are often available through classified add sites including ksl.com/classified for about $20.
7-Anti-static drum liners made of either high or low density polyethylene from 15mil - 24 mil thick and having extremely high resistance i.e. 10^{11} Ohms and meeting MIL-B-81705-C are available for $10 to $14 at CDF Corp and other sites on the web. The liners extend above the top of the container and about 1/2 inch must be trimmed of to allow the lid to close. Since the top of the liner is not sealed, the container should not be filled to more than several inches from the top to avoid possible arcing. If heavy sharp objects are placed in the container, it would be wise to provide plywood or similar material on the inside floor of the liner to prevent cutting the liner.

4.1.2 Containers Used For Long-Term Storage Of Large Equipments Not Requiring MIL-SPEC-125

Large 4'x3'x3' Sheet-Metal Container With Edges Wrapped With Aluminum Tape

1-A metal box was built by a sheet metal shop using "slip & lock" techniques to connect all sides at the edges. All edges were then taped over with aluminum foil to block signal leakage. The 4' x 3' front opening allowed 2" X 3" wood boards to be inserted inside around the opening. This enabled a front plate to be tightly attached to the container using screws. The front face plate edges were then taped over. This resulted in a measured suppression level of 60 dB at 1.92 GHz, i.e. 66 dB at 1 GHz.
2- The container is used for long term storage since it cannot be easily opened and closed.
3-The container provides a protected storage place primarily for large motor driven equipment. This includes as large electric power generators, small refrigerators, and spare kitchen appliances including microwave ovens, grain mills, blenders and juicers. The stored equipments are not intended to be used until after an EMP strike.
4-The suppression provided should reduce the inside voltage to about 20 volts/meter which is sufficient for motor driven equipment. It is insufficient for electronic equipment containing micro chips unless they are also nested within additional containers. By nesting, the suppression requirements of MIL-188-125 can be satisfied for microchip electronic equipment.
5-The container is made of heavy gauge sheet metal and is very rugged
6- A container of this type can be built by most metal shop for about $175
7-The stored equipment will sit on an inside wood floor and will be stored away from the sides of the containers to prevent arcing.

Large 6'x3'x1' Used Steel Cabinets And Book Shelves With Edges Wrapped With Aluminum Tape

1-Tall, all metal bookshelves, when provided with doors or a sheet metal front plate and aluminum foil tape to block signal leakage at all sides and corners, can be used for long-term storage and protection of solar panels and other tall items. These containers have not yet been measured for EMP suppression level. Based upon tests of the other containers, it is expected they will measure about 50 dB to 60 dB at 1 GHz.
A Warning of Miss-information #3: Some have claimed that solar panels do not need protection from EMP signals; however this has not been proven and there is little to zero evidence that they won't be damaged. Solar panels typically have a very large conducting surface with many solder points connecting the individual cells. They also contain reverse-current diodes which can easily be destroyed by high voltages. When in use, they are connected to a long cable which connects them to their controller. This cable acts as a large antenna for attracting the EMP energy. Their controller is completely full of electronics. In order to have hope of any type of protection, all parts must be disconnected. Based upon their size and without being disconnected, solar panels could receive hundreds of thousands of volts causing all types of damage.
My solar panels must work following any EMP strike. Until proven otherwise, I intend to protect mine by storing them in containers of this type. I will continue to use the electrical grid as long as it still works and will only bring my solar panels out of storage following the end of EMP strikes.
2- The suppression level provided by these type containers should reduce the inside voltage to around 50 to 160 volts/meter which should be sufficient for protecting solar panels. Note: The solar panel controllers contain electronics requiring 80db or more protection therefore they need to be stored separately in a 5 gallon pails to achieve this level of protection.

3-This container is made of heavy gauge sheet metal and is very rugged. It will need to be bolted to a wall for support and taped.
4-Used containers of this type can often be purchased at stores which sell used items (including the DI stores) for $15 to $20.
5-The containers are large enough that my solar panels inside can be spaced several inches away from all sides of the container. Also anti-static sheet material can be wrapped around them to protect against arcing.

4.1.3 Small Containers Which Have Easy Access But Need To Be Nested With Others

Microwave-Ovens (Large And Small) With Nesting Of Other Faraday Bags/Cages But Without Aluminum Tape
1-These have a measured signal suppression of approximately 40 dB at 1.92 GHz, i.e. 46 dB at 1 GHz with cord attached.
2-The doors are easily opened and stay closed after being closed, unless damaged
3-They can be used as convenient storage place for small equipments used frequently
4- The suppression provided should reduce the inside voltage to around 200 to 300 volts/meter which is insufficient for microchip electronic equipment. Nesting the equipment with other containers such as paint cans and faraday bags can be done to satisfy the suppression requirements of MIL-188-25 if this is required. The larger ones can hold several paint cans
5-These are rugged but are very hard to handle since they are heavy, bulky and waste storage space. While they help protect items inside, they themselves will probably not operate following an EMP strike since their electronics are outside the protected area.
6-Used ovens are often available from used-equipment stores (such as DI) for $20 to $40 depending on size and condition. The power cord should be removed so as to not function as an antenna.
7-Anti-static bags will be required unless the inside of the oven and the doors are non-conductive material

Ziploc Faraday/Mylar Bags Nested with Other Faraday Bags But Without Aluminum Tape
1-These have a measured signal suppression of 30 to 44 dB at 1.92 GHz i.e. 36 to 50 dB at 1 GHz depending on type, size and brand.
2- The Ziploc bag is easy to open and close
3-The easy access allows equipment stored inside to be used on a daily basis, however care must be taken to insure the Ziplock is closed tightly each time the equipment is returned to storage.
4- The suppression provided should reduce the inside voltage to around 150 to 1000 volts/meter which is insufficient for both microchip electronic and motor driven equipment. Depending on the bag, several levels of nesting may be required to satisfy the suppression requirements of MIL-188-125. A single TeckProtect bag inside another does satisfy the 80 dB requirement.
5-These are made of several layers of Mylar and aluminum foil which make them fairly rugged, but not as rugged as steel containers
6-These are available through TeckProtect, 3M, and Emergency Essentials from $2 to $100 depending on size and quality.
7-Some, but not all, of these are anti-static bags which need no additional insulation

Cans with Slip-Type Lids Nested With Faraday Bags But Without Aluminum Tape
1-A 2-gallon popcorn can with slip type lid was tested and found to have suppression of 38 dB at 1.92 GHz, i.e. 44dB at 1 GHz. without aluminum tape. With tape, the suppression was measured at 85 dB at 1.92 GHz, i.e. 91 dB at1 GHz.
2-.Containers having tight fitting slip type lids are sometimes hard to open without bending them and modifying the suppression.
3-The slip-on lid on some containers allows limited access due to the difficulty of removing the lid
4-Their suppression is insufficient (without being taped) for microchip electronic equipment; however faraday bags could be nested inside these to reach the 80 dB suppression requirement and still allow access to the equipment
5-These are usually made of thin metal which can be bent if handled roughly
6-They can be purchased on the internet for a few dollars
7- No insert liners have been identified; however anti-static bags could be used for inside insulation

4.1.4 Containers Which Must Be Taped Thus Restricting Access to The Equipment

Note: Most aluminum tapes are too narrow, too thin and weak or they are so sticky and are impossible to remove without the use of a razor blade or chisel. One can spend hours removing some of this before the container can be resealed. A very good tape for sealing containers is: "Ideal Seal 2000 or Ideal Seal 587 A/B" available on the web.

Cans With Slip-On Type Lids With Aluminum Tape
1-A 2-gallon popcorn can with slip type lid was tested and it had suppression of 38 dB at 1.92 GHz and 44dB at 1 GHz. without aluminum tape. With the tape the suppression was measured at 85 dB at 1.92 GHz, and 91 dB at1 GHz.
2-.Containers having tight fitting slip lids are a generally a bit hard to open without bending them
3-The slip-on lid on some containers allows limited access due to the difficulty of removing the lid without bending the can
4-Their suppression is not sufficient by themselves for equipment containing micro chip electronics; however faraday bags could be used with these to reach the 80dB suppression requirement
5-These are usually made of thin metal which can be bent if handled roughly
6-They can be purchased on the internet for a few dollars
7- No insert liners have been identified; however anti-static bags can be used for inside insulation

Metal Garbage Cans

1-By taping over all holes, including the handle connections on both the lid and on the sides, the gap between lid and can, and the seams on both sides and on the bottom, and by using two bungee cords to hold the lid tight, the measured signal suppression was 72 dB at 1.92 GHz frequency, i.e. 78 dB at 1 GHz. Without the aluminum tape, the one I tested leaked terribly, even with a tight fitting lid. It would be hard to find one of these that would provide even 5 dB of signal suppression at 1 GHz.
2-The lid is not easy to open and close since it must be re-taped each time the lid is opened and closed
3-They are useful only for equipment which is not being used frequently.
4-They could possibly be used for certain electronic equipment, but they do not meet the minimum 80 dB requirement even with tape
5- The garbage can itself is rugged but the lid attachment method is not. Also, heavy weight items can cause the bottom of garbage cans to bend downward opening it up to possible energy leakage. They will need a floor support if heavy items are stored in them.
6-These are available at most hardware stores for $20 to $30 dollars
7-There appears to be no anti-static, high resistant inserts available for this type container making them problematic unless some type of large anti-static liner or bag can be found which fit them.

Ammo Boxes

1-Two standard ammo cans were measured without being taped. The smaller box was 3 ½"wide and the other was 6"wide. The smaller box had a very tight lid and measured 24 dB of suppression at 1.92GHx, i.e. 30 dB at 1 GHz. The larger box lid was not as tight and measured 5 dB of suppression at these frequencies.
2-The boxes were easy to open and close due to the lid type
3-Ammo boxes come in many sizes. Measurements show that as the box size increases, so does the signal leakage. Also their shape and size limits the type and amount of equipment that can be stored in them.
4-Without being taped, these type containers do not have sufficient signal suppression to be used for protecting micro chip electronics even with nesting. Aluminum tape could possibly bring the suppression levels up near to 80 dB mark but this makes them no longer easy to open and close. Neither of the cans were measured with tape.
5-Ammo boxes are very rugged
6-Ammo boxes are readily available at army surplus stores for around $10 to $30 depending on size and condition
7-No anti-static liners for these was found, however anti-static sheeting or bags do exist which could be used with these.

Open Ended Mylar Food Storage Bags

1-By taping the top of these with aluminum tape, they provide measured signal suppression of about 36 dB at 1.92 GHz frequency, i.e. 42 dB at 1 GHz.
2-They are not easily opened and close since they must be re-taped each time they are closed.
3-They are useful only for small equipment which will be used infrequently.
4-They could possibly be used for certain electronic equipment in long-term storage, but they do not meet the minimum 80 dB requirement without being nested with other containers
5- These are made of several layers of Mylar and aluminum foil which make them fairly rugged, but not as rugged as steel containers
6- These can be purchased through LDS dry pack centers for about $0.30
7- These are not anti-static bags but they could be nested with anti-static bags for the required insulation

5.0 Protecting Equipment That Are Too Large For Faraday Cages

The home has many feet of electric wire running throughout the house which act as an antenna for the EMP energy. One would like to prevent damage to equipment which is either in continual use, hard-wired directly into the house or are too large to fit within a Faraday cage. This would include equipment like automobiles, furnaces, central air conditioner, large refrigerators/freezers, garage door openers, large TVs, whole-house generators and portable generators. While there are many limitations with these and the costs are high, Jerry Emanualson at www.futurescience.com/emp/EMP-sitemap.html provides a few suggestions on devices that can help if the EMP is low yield or far away. They do not guarantee sufficient protection for every type EMP event and they are expensive typically ranging from one to five hundred dollars each. These consist of various types of transient suppression devices which can be connected at the power input location of the house and others positioned throughout the house at locations where equipment is connected. These devices must be able to respond to the EMP-E1 signal within one to two nano seconds in order to be of any value. There are very few devices capable of doing this which accounts for their high costs. One must evaluate the risk of losing one's equipment and the associate replacement cost compared to the cost of installing such devices.

Figure 4. Example 55-Gallon Drum, 5-Gallon Pale, 1-Gallon Paint Can and Teck-Protect Bag Type Faraday Cage

6.0 Using Your Faraday Cages

Your faraday cage should become the primary storage place for all of the equipment which you are going to need following an EMP event. Your easy-access containers will hold the equipment that you need to use frequently. Once an item is removed from the container, the lid should be sealed again in case the EMP occurs while using the equipment. This will prevent damage to the remaining items in the container. If an item is critical to one's life after EMP, then multiples of that item should obtained with each stored in different faraday cages. The enemy may send multiple EMPs our way, one following the other, or they could be spaced out over time, depending on his assessment of the success of his previous attacks. It would be wise to wait for a several days after an attack before opening any of the faraday cages. Having redundant critical equipments stored in different faraday cages could possibly save at least some of them.

Note that Faraday cages which are stored on a non-conducting surface such as wood or carpet or which are on rubber wheels (allowing them to be moved easily) could hold an electrical charge for some time following an EMP event. It would be wise to discharge any residual charge before touching the metal. This can be done using a grounding wire and touching it to the container to bleed of the charge.

While some of the Faraday cages can be stacked, this will increase the size/length of the conducting cages increasing the volts/meter induced on the stack of cages. Example: A single 5 gallon pail is about 1/3 of a meter while a stack of three is one meter resulting in three times the voltage induced. Best to keep the size small.

7.0 Storing, Locating, And Retrieving Your Protected Items.

As one begins to identify the items which are considered to be critical for one's survival following an EMP event, the list of items will begin to grow large and complex. These items will be of many different sizes and will require different levels of suppression. Multiple faraday cages of different type could be required and one will soon lose track of where things are being stored.
The solution I use is to categorize and store items similar to filing items in a file cabinet. There is a master inventory list of all categories and within each category, are the items stored and the container containing them. I use only four type of containers, i.e. the 5 gallon pail, the 55 gallon drum the 3 x 3 x 4 foot box and the two 6 x 3 x 1 foot book shelves. I store all my sensitive electronic items in the 5 gallon units and the electric motor items in the 55 gallon units. Larger equipment are stored in the larger containers. I mark each container with both the category and a number and record this on the master list with the item entry. When looking for my blood pressure meter for example, I simply look on the master list for category equal "Medical" and the item equal "Blood Pressure Meter". This gives me the 5 gallon container number it is stored in. I currently use the following categories for my critical items: Power items, Tool items, Lighting items, Heating/Cooking items, Medical items, Communication items, Toiletry items, Kitchen items, Information items, Security/Alarm items, Convenience items. The categories can be assigned to fit whatever the need is.

8.0 Measuring The Effective Suppression (ES) Of Your Faraday Container

Certifying that a piece of equipment shielding satisfies the requirements of MIL-STD-188-125 requires very expensive test equipment which can generate test signals having controlled signal strength at a specified distance and throughout the specified frequency range. Without such controls, the results will be erratic and inaccurate. The cost of such equipment is far out of reach for the average person; however one still needs a way to at least approximate the dB suppression levels of his containers in order to insure they are going to protect his equipment.

An inexpensive way to do this is to obtain two containers which have known dB suppression levels over the required frequency range and to use these as a standard against which to compare the suppression levels of other containers being tested. A signal source is needed which consistently generates the same frequency and signal strength each time it is used. The signal frequency needs to be at, or slightly above, the 1.5 GHz identified by the military as the upper bound of the EMP frequency. A physical test location is needed which will remain constant as to the objects which attenuate the test signal during the tests. The test location must by sufficiently large so as to allow measurement of the suppression effectiveness of both of the measurement standards.

To conduct my measurements, I purchased two zip lock TeckProtect Faraday bags, one larger than the other, via the internet (approximately $20 including shipping). Both bags were rated at over 40 dB within the required EMP frequency range. For test purposes, I assumed they were 42 dB at 1.92 GHz.

When they arrived, I extended my telephone line outside to a clear area with no tree, auto, walls homes or other obstructions for several hundred feet. The area was at the end of a cul-de-sac with snow on the lawns and on the road but with the drive ways dry. The sun was shining, it was 34-35 degrees Fahrenheit and there was very little pollution in the air.

I chose my Vtech cordless telephone base as the signal generator for constant signal strength and a constant frequency of 1.925 GHz. The Vtech handset was used as the receiver being located within the test container. Typically the signal from a non-directional antenna of this type can be expected to decrease in strength inversely with the square of the distance assuming no obstacles are in the way to attenuate the signal. <u>Note</u>: I chose the cordless phone system rather than the cell phone tower as the signal generator for two reasons: First, the cell phone operates at a lower frequency (0.824 GHz) than the upper limit of the EMP frequency. This would register higher suppression results than would actually exist at the upper frequency of the EMP signal. At 1.92 GHz, my suppression measurements should read 6 dB to 7 dB low. Second: the cell phone tower is a long ways away resulting in the signal level strength not remaining constant due to the snow, trees, buildings automobiles and other items attenuating the signal. I used my cell phone to call my home number and thus activate the cordless phone base.

I measured the smaller TeckProtect faraday bag (with phone handset inside), to determine the maximum distance that the signal could be received between the telephone base and the handset. Upon finding this point, it became the distance (in feet on the horizontal axis) which equated to 42 dB (on the vertical axis) of a graph shown below in Figure 4. I then put the smaller TeckProtect bag inside the larger one, with handset inside the two, and measured the distance the same as before. This distance became the 84 dB point (i.e. 2X 42) on the same graph. Connecting the two dots established the relationship between maximum signal distance and dB suppression for my configuration. Having established this, I proceeded to measure the maximum signal distance for each of the various containers reading their corresponding dB suppression value from the graph. Test results of measurements comparing different containers are shown below in Figure 4.

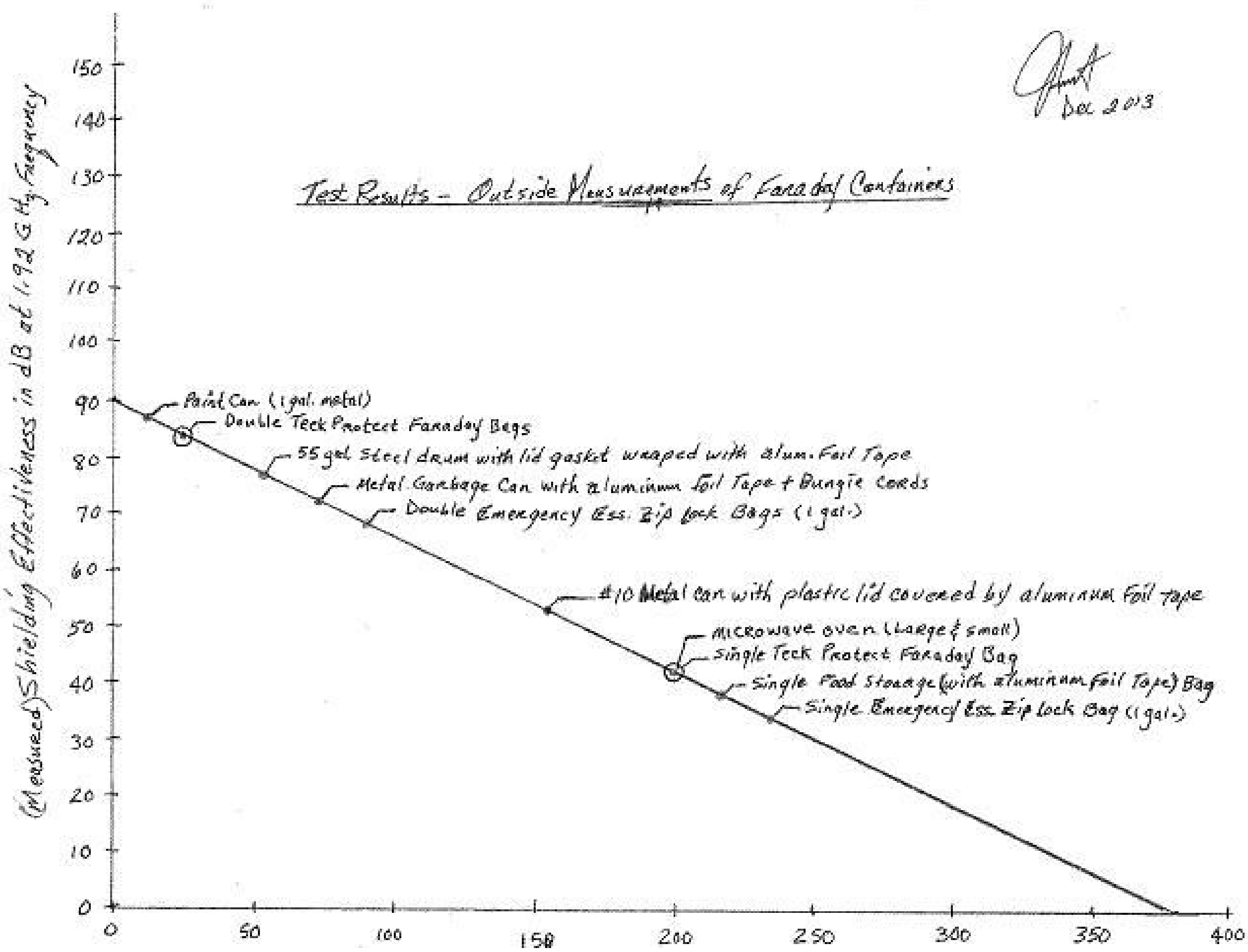

Figure 4. Outside Test Results Of Faraday Containers

<u>Note:</u> I followed the above procedure inside my home with the phone base located at one end of the home in a library to see the affect on the signal of the obstructions in the home. There was a wall, a kitchen with appliances, a kitchenette, and the family room between the phone base and handset. This significantly attenuated the signal and slightly distorting the test results due to the attenuating obstructions not being equally distributed. The maximum signal distance measured outside at the 42 dB point was 200 feet with 25 feet for the 84 dB point. Measuring inside, the 42dB point was reduced to 60 feet and for the 84 dB point was reduced to 2 feet. Even though the two test location graphs showed a different number of feet per dB of suppression, the relative dB pattern for the different containers remained somewhat similar. Where the obstructions were greatest in the home, the higher suppressing containers measured low, e.g. the paint-can measure 76 dB inside versus 87dB outside. Lower suppressing containers measured the same, e.g. microwave ovens measured 40 dB in both configurations. The above results demonstrate the need for a clear unobstructed test area in order to obtain the most accurate results. It also shows that this measurement technique can be used to obtain fairly accurate results concerning the signal suppression capacity of various containers even when using an imperfect test location having obstructions such as kitchen appliances, trees, bushes, fences, and walls.

9.0 Definition Of Terms Used

1. The **decibel** (**dB**) is a logarithmic unit used to express the ratio between two values of a physical quantity. One of these quantities is often a reference value, and in this case the dB can be used to express the absolute level of the physical quantity. The decibel is also commonly used as a measure of gain or attenuation, the ratio of input and output powers of a system, or of individual factors that contribute to such ratios. The number of decibels is ten times the logarithm to base 10 of the ratio of the two power quantities. A decibel is one tenth of a **bel**, a seldom-used unit named in honor of Alexander Graham Bell. The decibel is used for a wide variety of measurements in science and engineering. In electronics, the gains of amplifiers, attenuation of signals, and signal-to-noise ratios are often expressed in decibels. The decibel confers a number of advantages, such as the ability to conveniently represent very large or small numbers, and the ability to carry out multiplication of ratios by simple addition and subtraction. A change in power by a factor of 10 is a 10 dB change in level. A change in power by a factor of two is approximately a 3 dB change. A change in voltage by a factor of 10 is equivalent to a change in power by a factor of 100 and is thus a 20 dB change. A change in voltage ratio by a factor of two is approximately a 6 dB change. The definitions of the decibel and bel use base 10 logarithms. The neper, an alternative logarithmic ratio unit sometimes used, uses the natural logarithm (base *e*).
2. mm: denotes length of millimetre or 1000th of a meter
3. MHz: denotes million of cycles per second or 10^6 cycle per second
4. GHz: denotes frequency of billion of cycles per second or 10^9 cycles per second
5. ns: denotes nanosecond which is one billionth of a second

10.0 ReleatedTopics and Reports

Related topics include:
1) EMP protection of larger electrical equipments which can be disconnected from the power grid but which cannot always be protected using faraday cages,
2) EMP protection of household equipments which must remain connected to the power grid for normal living
3) EMP protection of gasoline/diesel engine equipment and vehicles
4) Building an EMP proof shed to house and operate a gasoline generator with fresh air intake and exhaust capability.

10.1 Manual Start Portable Generators

Older type portable generators which have actual generator windings without electronics may survive an indirect EMP. Some of these have several diodes required to produce the DC voltage use to charge batteries and running DC equipment. The diodes may fail but the unit may still work on the AC voltage after an EMP.
If the portable generator is the newer light weight type, it probably is an electronic alternator type unit. If the generator has obvious electronic features, check the schematics and be sure to have spare parts for the electronics. Protect these units in a faraday cage if possible. In all cases do not connect extension cords into any portable generators until you need them.
At www.futurescience.com/emp/generators.html Jerry Emanualson has the following suggestion: 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, but it takes a lot more energy to punch through enamel insulation than to damage microelectronics, so it is 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.)
(Actually, in some 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.)

10.2 Whole-House Generators, Furnaces, Central Air Conditioners, Refrigerators, Garage-Door Openers, etc

-To be completed at a later time.

10.3 Gasoline Engine Equipment
-To be completed at a later time.

10.4 Outside Gasoline Generator Shed
- To be completed at a future time

11.0 The Urgency Of Preparing

Preparations are somewhat urgent since an attack of this type could come at any time from al-Qaeda, Iran and its proxies, North Korea, Russia and its surrogates, and/or China and its surrogates. Several enemy countries have openly declared that this is their intent, their method and their plan to take down America. – See Attachment A below.

It does not take a large nuclear weapon or a great missile to produce this type of destruction. A small multi-kiloton weapon of the size North Korea recently tested could do this. North Korea and Iran have recently conducted missile tests launching from ships and have demonstrated their capacity to remotely detonate the weapons. Scud missiles left over from the Soviet Union, while not very accurate, could be used for this purpose and they are available on the black market for $100,000. Al-Qaeda has approximately 100 ships capable of functioning as launching platforms. The weapon could be launched from ships in international waters within the Gulf of Mexico or from the east and/or west cost or both. The weapon could also be launched from a foreign country sending it over the south pole where we have no missile defense, or it could be put into orbit and detonated remotely when crossing over America.
The Blaze News recently reported that in July 2014, North Korea sent a freighter into the Gulf of Mexico carrying two SA-3 missiles in their launchers covered over by thousands of bags of sugar. The missiles were of the type which can launch nuclear weapons capable of creating an EMP event but they were not carrying the nuclear warheads at that time. They went undetected in the Gulf of Mexico and then attempted to pass through the Panama Canal where they were stopped under suspicion of drug smuggling. Some suggest that this was a dry run for a future EMP strike from the Gulf of Mexico and that they were attempting to pass through the Panama Cannel in order to reach the west coast of the U.S. for possible dry run of a EMP missile launch from there as well..

Russia, China and North Korea now claim to have developed Super EMPs which can defeat our military preparations by producing EMPs capable of producing 200,000 volts/meter pulses. What constitutes a "Super EMP" weapon is classified information not being discussed on the internet. Speculating: It could possibly have multiple meanings. 1) a more directional and higher intensity of gamma ray yield using a thinner shell producing less heat, 2) new principles employed resulting in a faster pulse rise time, longer duration or more intensity.

Note: In a popular fictional book "One Second After" by William R. Forstchen, the people in a small town were not prepared when a EMP strike occurred. They had little to no food storage and Faraday cages were not in use to protect their equipment. Their insulin and other medications could not be refrigerated. They were left without grain grinders and no way to cook. They had few gardening tools and seeds. Their communications equipment, late model cars, solar panels and electric power generators no longer worked and they had no way to sterilize the water. In the book, 900 persons died of starvation in the first month and in six weeks 2000 were dead. And within 12 months 80-90% of the population had died. Many private and military experts suggest this outcome may be realistic.

For additional detail on this and related subjects, go to:
www.futurescience.com or search the web for "The Carrington Effect"
http://www.youtube.com/watch?v=Tt8gsl_PlPQ and
"The Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack".
http://www.empcommission.org/docs/empc_exec_rpt.pdf or
Or for general info at http://www.youtube.com/watch?v=vn6OVLK0MBI

Attachment A:

STATEMENT
DR. PETER VINCENT PRY
EMP COMMISSION STAFF
BEFORE THE
UNITED STATES SENATE
SUBCOMMITTEE ON TERRORISM, TECHNOLOGY AND HOMELAND SECURITY
March 8, 2005

FOREIGN VIEWS OF ELECTROMAGNETIC PULSE (EMP) ATTACK

The EMP Commission sponsored a worldwide survey of foreign scientific and military literature to evaluate the knowledge, and possibly the intentions, of foreign states with respect to electromagnetic pulse (EMP) attack. The survey found that the physics of EMP phenomenon and the military potential of EMP attack are widely understood in the international community, as reflected in official and unofficial writings and statements. The survey of open sources over the past decade finds that knowledge about EMP and EMP attack is evidenced in at least Britain, France, Germany, Israel, Egypt, Taiwan, Sweden, Cuba, India, Pakistan, Iraq under Saddam Hussein, Iran, North Korea, China and Russia.

Numerous foreign governments have invested in hardening programs to provide some protection against nuclear EMP attack, indicating that this threat has broad international credibility. At least some of the new nuclear weapon states, notably India, are concerned that their military command, control, and communications may be vulnerable to EMP attack. For example, an Indian article citing the views of senior officers in the Defense Ministry (including General V. R. Raghavan) concludes: "The most complicated, costly, controversial and critically important elements of [nuclear] weaponisation are the C3I systems....Saving on a C3I system could be suicidal. With a no-first-use policy, the Indian communications systems have to be hardened to withstand the electromagnetic pulses generated by an adversarial nuclear first strike. Otherwise, no one will be fooled by the Indian nuclear deterrent."
(C. Rammonohar Reddy, **The Hindu**, 1 September 1998)

Many foreign analysts perceive nuclear EMP attack as falling within the category of electronic warfare or information warfare, not nuclear warfare. Indeed, the military doctrines of at least China and Russia appear to define information warfare as embracing a spectrum ranging from computer viruses to nuclear EMP attack. For example, consider the following quote from one of China's most senior military theorists–who is credited by the PRC with inventing information warfare– appearing in his book **World War, the Third World War–Total Information Warfare**: "With their massive destructiveness, long range nuclear weapons have combined with highly sophisticated information technology and computer technology today and warfare of the looming 21st century: information war under nuclear deterrence....Information war and traditional war have one thing in common, namely that the country which possesses the critical weapons such as atomic bombs will have 'first strike' and 'second strike retaliation' capabilities....As soon as its computer networks come under attack and are destroyed, the country will slip into a state of paralysis and the lives of its people will ground to a halt Therefore, China should focus on measures to counter computer viruses, nuclear electromagnetic pulse...and quickly achieve breakthroughs in those technologies in order to equip China without delay with equivalent deterrence that will enable it to stand up to the military powers in the information age and neutralize and check the deterrence of Western powers, including the United States." (2001)

Some foreign analysts, judging from open source statements and writings, appear to regard EMP attack as a legitimate use of nuclear weapons, because EMP would inflict no or few prompt civilian casualties. EMP attack appears to be a unique exception to the general stigma attached to nuclear employment by most of the international community in public statements.
Significantly, even some analysts in Japan and Germany–nations that historically have been most condemnatory of nuclear and other weapons of mass destruction in official and unofficial forums–appear to regard EMP attack as morally defensible. For example, a June 2000 Japanese article in a scholarly journal, citing senior political and military officials, appears to regard EMP attack as a legitimate use of nuclear weapons: "Although there is little chance that the Beijing authorities would launch a nuclear attack, which would incur the disapproval of the international community and which would result in such enormous destruction that it would impede postwar cleanup and policies, a serious assault starting with the use of nuclear weapons which would not harm humans, animals, or property, would be valid. If a...nuclear warhead was detonated 40 kilometers above Taiwan, an electromagnetic wave would be propagated which would harm unprotected computers, radar, and IC circuits on the ground within a 100 kilometer radius, and the weapons and equipment which depend on the communications and electronics technology whose superiority Taiwan takes pride in would be rendered combat ineffective at one stroke...If they were detonated in the sky in the vicinity of Ilan, the effects would also extend to the waters near Yonakuni [in Okinawa], so it would be necessary for Japan, too, to take care. Those in Taiwan, having lost their advanced

technology capabilities, would end up fighting with tactics and technology going back to the19th century...They would inevitably be at a disadvantage with the PLA and its overwhelming military force superiority." (Su Tzu-yun, **Jadi**, 1 June 2000)

An article by a member of India's Institute of Defense Studies Analysis openly advocates that India be prepared to make a preemptive EMP attack, both for reasons of military necessity and on humanitarian grounds: "A study conducted in the U.S. during the late 1980s reported that a high-yield device exploded about 500 kilometers above the ground can generate an electromagnetic pulse (EMP) of the order of 50,000 volts over a radius of 2,500 kilometers around the point of burst which would be collected by any exposed conductor. Such an attack will not cause any blast or thermal effects on the ground below but it can produce a massive breakdown in the communications system....It is certain that most of the land communication networks and military command control links will be affected and it will undermine our capability to retaliate. This, in fact, is the most powerful incentive for a preemptive attack. And a high-altitude exo-atmospheric explosion may not even kill a bird on the ground." (**The Indian Express**, 17 September 1999)

Although India, Pakistan, and Israel are not rogue states, they all presently have missiles and nuclear weapons giving them the capability to make EMP attacks against their regional adversaries. An EMP attack by any of these states–even if targeted at a regional adversary and not the United States–could collaterally damage U.S. forces in the region, and would pose an especially grave threat to U.S. satellites.

Many foreign analysts–particularly in Iran, North Korea, China, and Russia–view the United States as a potential aggressor that would be willing to use its entire panoply of weapons, including nuclear weapons, in a first strike. They perceive the United States as having contingency plans to make a nuclear EMP attack and as being willing to execute those plans under a broad range of circumstances.

Russian and Chinese military scientists in open source writings describe the basic principles of nuclear weapons designed specifically to generate an enhanced-EMP effect, that they term "Super-EMP" weapons. "Super-EMP" weapons, according to these foreign open source writings, can destroy even the best protected U.S. military and civilian electronic systems.

Chinese military writings are replete with references to the dependency of United States military forces and civilian infrastructure upon sophisticated electronic systems, and to the potential vulnerability of those systems. For example, consider this quote from an official newspaper of the PLA: "Some people might think that things similar to the 'Pearl Harbor Incident' are unlikely to take place during the information age. Yet it could be regarded as the 'Pearl Harbor Incident' of the 21st century if a surprise attack is conducted against the enemy's crucial information systems of command, control, and communications by such means as...electromagnetic pulse weapons....Even a superpower like the United States, which possesses nuclear missiles and powerful armed forces, cannot guarantee its immunity...In their own words, a highly computerized open society like the United States is extremely vulnerable to electronic attacks from all sides. This is because the U.S. economy, from banks to telephone systems and from power plants to iron and steel works, relies entirely on computer networks....When a country grows increasingly powerful economically and technologically...it will become increasingly dependent on modern information systems....The United States is more vulnerable to attacks than any other country in the world." (Zhang Shouqi and Sun Xuegui, **Jiefangjun Bao** 14 May 1996)

Russian military writings are also replete with references to the dependency of United States military forces and civilian infrastructure upon sophisticated electronic systems, and to the potential vulnerability of those systems. Indeed, Russia made a thinly veiled EMP threat against the United States on May 2, 1999. During the spring of 1999, tensions between the United States and Russia rose sharply over Operation ALLIED FORCE, the NATO bombing campaign against Yugoslavia. A bipartisan delegation from the House Armed Services Committee of the U.S. Congress met in Vienna with their Russian counterparts on the Duma International Affairs Committee, headed by Chairman Vladimir Lukin. The object of the meeting was to reduce U.S. -Russia tensions and seek Russian help in resolving the Balkans crisis. During the meeting, Chairman Lukin and Deputy Chairman Alexander Shaponov chastised the United States for military aggression in the Balkans, and warned that Russia was not helpless to oppose Operation ALLIED FORCE: "Hypothetically, if Russia really wanted to hurt the United States in retaliation for NATO's bombing of Yugoslavia, Russia could fire a submarine launched ballistic missile and detonate a single nuclear warhead at high-altitude over the United States. The resulting electromagnetic pulse would massively disrupt U.S. communications and computer systems, shutting down everything." (HASC Transcript On Vienna Conference, 2 May 1999)

Iran, though not yet a nuclear weapon state, has produced some analysis weighing the use of nuclear weapons to destroy cities, as "against Japan in World War II," compared to "information warfare" that includes "electromagnetic pulse...for the destruction of unprotected circuits." An Iranian analyst describes "terrorist information warfare" as involving not just computer viruses but attacks using "electromagnetic pulse (EMP)."
(Tehran, **Siyasat-e Defa-I**, 1 March 2001)

An Iranian political-military journal, in an article entitled "Electronics to Determine Fate of Future Wars," suggests that the key to defeating the United States is EMP attack: "Advanced information technology equipment exists which has a very high degree of efficiency in warfare. Among these we can refer to communication and information gathering satellites, pilotless planes, and the digital system....Once you confuse the enemy communication network you can also disrupt the work of the enemy command and decision-making center. Even worse, today when you disable a country's military high command through disruption of communications you will, in effect, disrupt all the affairs of that country....If the world's industrial countries fail to devise effective ways to defend themselves against dangerous electronic assaults, then they will disintegrate within a few years....American soldiers would not be able to find food to eat nor would they be able to fire a single shot." (Tehran, **Nashriyeh-e Siasi Nezami**, December 1998 -January 1999

Iranian flight-tests of their Shahab-3 medium-range missile, that can reach Israel and U.S. forces in the Persian Gulf, have in recent years involved several explosions at high altitude, reportedly triggered by a self-destruct mechanism on the missile. The Western press has described these flight-tests as failures, because the missiles did not complete their ballistic trajectories. Iran has officially described all of these same tests as successful. The flight-tests would be successful, if Iran were practicing the execution of an EMP attack.

Iran, as noted earlier, has also successfully tested firing a missile from a vessel in the Caspian Sea. A nuclear missile concealed in the hold of a freighter would give Iran, or terrorists, the capability to perform an EMP attack against the United States homeland, without developing an ICBM, and with some prospect of remaining anonymous. Iran's Shahab-3 medium-range missile, mentioned earlier, is amobile missile, and small enough to be transported in the hold of a freighter.

We cannot rule out that Iran, the world's leading sponsor of international terrorism, might provide terrorists with the means to execute an EMP attack against the United States.

In closing, a few observations about the potential EMP threat from North Korea.

North Korean academic writings subscribe to the view voiced in Chinese, Russian, and Iranian writings that computers and advanced communications have inaugurated an "information age" during which the greatest strength, and greatest vulnerability, of societies will be their electronic infrastructures. According to North Korean press, Chairman Kim Chong-il is himself supposedly an avid proponent of this view. (M.A. Kim Sang-hak, "development of Information Industry and Construction of Powerful Socialist State," **Pyongyang Kyongje Yongu**, 20 May 2002)

The highest ranking official ever to defect from North Korea, Hwang Chang-yop, claimed in 1998 that North Korea has nuclear weapons and explained his defection as an attempt to prevent nuclear war. According to Hwang, in the event of war, North Korea would use nuclear weapons "to devastate Japan to prevent the United States from participating. Would it still participate, even after Japan is devastated? That is how they think." Although Hwang did not mention EMP, it is interesting that he described North Korean thinking about nuclear weapons employment as having strategic purposes– nuclear use against Japan–and not tactical purposes–nuclear employment on the battlefield in South Korea. It is also interesting that, according to Hwang, North Korea thinks it can somehow "devastate" Japan with its tiny nuclear inventory, although how precisely this is to be accomplished with one or two nuclear weapons is unknown.

Perhaps most importantly, note that the alleged purpose of a North Korean nuclear strike on Japan would be to deter the United States. At the time of Hwang's defection, in 1998, North Korea's longest-range missile then operational, the No Dong, limited North Korea's strategic reach to a strike on Japan. Today, North Korea is reportedly on the verge of achieving an ICBM capability with its Taepo Dong-2 missile, estimated to be capable of delivering a nuclear weapon to the United States.

In 2004, the EMP Commission met with very senior Russian military officers, who are experts on EMP weapons. They warned that Russian scientists had been recruited by Pyongyang to work on the North Korean nuclear weapons program. They further warned that the knowledge and technology to develop "Super-EMP" weapons had been transferred to North Korea, and that North Korea could probably develop these weapons in the near future, within a few years. The Russian officers said that the threat to global security that would be posed by a North Korean armed with "Super-EMP" weapons is unacceptable. The senior Russian military officers, who claimed to be expressing their personal views to the EMP Commission, said that, while the Kremlin could not publicly endorse U.S. preemptive action, Moscow would privately understand the strategic necessity of a preemptive strike by the United States against North Korea's nuclear complex.

This concludes my statement. Thank you for the opportunity to share this information with the U.S. Senate and the American people.