

Solar Storm Disaster Preparedness Plan

I. General Discussion

WHEN a “Winter Storm Warning” is posted in the Midwest U.S., most country folks, even without being told, automatically head out to their nearest grocery store. They know that a bad winter storm may be on the way and its time to stock up on the necessities of life. In the grocery stores, the bread and milk aisles soon empty. This is a good example of effective preparedness planning and execution. These individuals have learned the hard way that a little preparation beforehand can alleviate a great deal of pain & misery after a blizzard strikes.

There are some forms of disasters that are relatively rare. Many are so rare that disaster preparedness planners don’t even consider them. This preparedness plan looks at the threat of massive solar storms. Most solar storms produce fairly mild effects and generally go unnoticed by civilization. But on rare occasions a solar storm can become so massive that it can develop into a major disaster within our high technology world.

The threat from solar storms is describe in the Solar Storm Threat Analysis available at: <http://BreadAndButterScience.com/SSTA.pdf>. This Preparedness Plan is a companion document to this analysis in which the threat is described in substantial detail.

Solar storms consist of three major components: solar flares, solar proton events (SPEs) and coronal mass ejections (CMEs). CMEs can interact with Earth’s magnetic field to produce a geomagnetic storm. Not all solar storms produce all three elements but the largest solar storms tend to. Solar flares can produce satellite communications interference, radar interference, shortwave radio fades and blackout and atmospheric drag on satellite producing an unplanned change in orbit. Solar proton events can produce satellite disorientation, spacecraft electronics damage, spacecraft solar panel degradation, extreme radiation hazard to astronauts, launch payload failure, high altitude aircraft radiation, shortwave radio fades and disruption in polar regions, ozone layer depletion, cardiac arrest, dementia and cancer. A CME can produce electrostatic spacecraft charging, shifting of the Van Allen radiation belt, spacetrack errors, launch trajectory errors, spacecraft payload deployment problems, surveillance radar errors, radio propagation anomalies, compass alignment errors, electrical power blackouts, oil and gas pipeline corrosion, communication landline & equipment damage, electrical shock hazard, electrical fires, heart attacks, strokes, and workplace & traffic accidents. For most individuals the primary threat from a massive solar storm is the potential for creating a widespread long duration electrical power blackout.

The Great Solar Storm of 1859 produced the only known white light solar flare, the strongest solar proton event with an omni-directional solar proton fluence of $2.0 \times 10^{10} \text{ cm}^{-2}$ and the largest coronal mass ejection generated geomagnetic storm ($\text{Dst} = 1,760 \text{ nT}$) ever observed. This solar storm was the greatest storm in at least the last 450 years. The goal of this plan is to alleviate some of the misery that may be encountered by a threat from a solar storm of this magnitude. The plan identifies both reactive (immediate, a day or two before the storm hits) and a proactive approach (long-term measures) that can minimize the effects from a massive solar storm. This plan will provide practical advice primarily focused on survival basics: water, food, shelter and protecting human life.

Unlike most solar storms, a Great Solar Storm comparable in size to the solar storm of September 1859 has the capacity of significantly damaging the electrical infrastructure at multiple points over a vast region resulting in a prolonged electrical blackout whose duration is measured in terms of months/years. There may be two types of North American blackout zones dependant on the intensity of the massive solar storm:

Stage I –New York, New Jersey, Connecticut, New Hampshire, Massachusetts, Vermont, Rhode Island, Maine, Michigan & Pennsylvania and the eastern half of Canada.

Stage II – All of Canada, East Coast, West Coast and Northern States in the U.S. (including all cities in Canada, Alaska, Oregon, Washington, Idaho, Montana, Wyoming, North Dakota, South Dakota, Nebraska, Minnesota, Iowa, Wisconsin, Illinois, Michigan, Indiana, Ohio, Pennsylvania, New York, New Jersey, Connecticut, New Hampshire, Massachusetts, Vermont, Rhode Island & Maine, and also the following major cities: Los Angeles CA, San Francisco CA, Bakersfield CA, Fresno CA, San Jose CA, Sacramento CA, Salt Lake City UT, Reno NV, Baltimore MD, Charleston WV, Denver CO, Grand Junction CO, Kansas City MO, Louisville, KY, Saint Louis MO, Washington DC, Huntsville AL, Chattanooga TN, Knoxville TN and Atlanta GA). In a Stage II blackout over 100 million Americans may be affected.

Least I paint too pessimistic a vision of this disaster; I will say that in America, “innovation” is our middle name. The goal of this plan is to help you survive and for you to help others survive until the innovation takes root and bears fruit. Adaptation and innovation is the rule. One needs to look forward during these times rather than looking backwards. One should not be part of the problem; but rather, part of the solution.

II. Advanced Warning

PREDICTING the intensity of a solar storm is not an exact science. As a matter of fact, the science is just in its infancy. So what type of advanced warning might we expect?

The Earth is a very small target in a vast region of space. Many solar storms even massive solar storms simply flow past the planet with little effect. The ability to forecast an impending threat with a reasonable degree of accuracy is a new scientific field. Several analytical approaches have recently been developed to forecast powerful solar storms and project a measure of their intensity.

- The Bear Alert (from Big Bear Solar Observatory) analyzes magnetic fields on the sun and forecast solar storm activity with a fair degree of success.
- Tracking great, S-shaped twists of plasma called sigmoids provides advanced early warning. These magnetic flux ropes are twisted magnetic field lines that store massive amounts of energy. Like a rubber band twisted too tightly, stressed magnetic fields in the sun's atmosphere can suddenly snap to a new shape. When they do, they can release as much energy as one 10-billion-megaton nuclear bomb. X-ray based observations provide a very detailed and inclusive picture of the magnetic structure of the sun. This tool provides forecasts two to three days in advance with approximately 50 percent accuracy.¹
- Another method that may provide warning of an impending SPE is to track the burst of electrons at the leading edge of the event. These electrons will arrive between 7-74 minutes ahead of the SPE and can be used to predict the intensity of the SPE burst of nuclear particles and ions. The COSTEP (Comprehensive SupraThermal and Energetic Particle) analyzer onboard the SOHO satellite can be used to provide this advanced warning.² Every radiation storm is a mix of electrons, protons and heavier ions. The electrons, being lighter and faster than the others, race out ahead.
- The largest solar storms appear to possess all three components of a solar storm (solar flare, SPE and CME). And the intensity appears to be scaled alike across all three components. Large SEP events have a 96% correlation with paired CME events. Therefore evidence of a white light flare or very high intensity x-ray flare and presence of a large SPE (one that overloads spacecraft sensors) may provide over a half day of advance warning for the arrival of the main geomagnetic storm. It was

shown that 89% of the “major geomagnetic storms have clear precursor effects, which can be used for forecasting a massive geomagnetic storm.”³

There are several websites available that provide a picture of potential solar storm activity. Refer to <http://www.solarcycle24.com/> <http://sohowww.nascom.nasa.gov/> and <http://www.spaceweather.com/>. If you hear the words “white light flare” being applied to a solar flare, it is time to sit up and take notice.

III. Reactive Approach

A. Recommended Actions Immediately Prior to Massive Solar Storm

This section provides practical advice for preparing for an imminent massive solar storm, one that is likely to produce a major blackout. This preparation should help you get through the first few days of the crisis.

- 1. *Extra Batteries*** – Obtain fresh batteries for flashlights and radios.
- 2. *Gasoline*** – During a blackout the majority of service stations will be unable to pump gasoline because pumps are powered by electricity. Fill up all your vehicles (automobiles, trucks, motorcycles) with fuel. At the same time, fill up all your spare gas cans.
- 3. *Cooking Fuel*** – During an electrical blackout, many of the appliances in your home including your cooking stove and range may become inoperative because most require electricity to operate. Determine your non-electric cooking options. For most individuals this will be an outdoor grill. Ensure that you have adequate supplies of charcoal for your outdoor grill along with matches and lighter fluid. If your grill runs off from propane, ensure that you have full propane tanks.
- 4. *Prescription Medicine*** – Access to prescription medicine will be very limited during power blackouts because most pharmacies are very automated for logging and dispensing prescriptions. Those who have chronic conditions that require regular refilling of prescriptions should work with their doctor to obtain a 3-month supply of medicine prior to the onset of the massive geomagnetic storm.
- 5. *Liquid Cash*** – A major electrical blackout can deprive individuals from access to their funds. Credit card processing, bank transactions, ATM machine withdrawals, electronic banking, check validation, payroll disbursement and even cash registers are dependent on the availability of electrical power. This problem can be compounded by the loss of key satellites that form part of the conduit for transmitting financial data. Having available cash on hand can be extremely important during this type of crisis. Obtain funds in the form of cash or traveler’s checks.
- 6. *Water*** – The loss of electricity may affect city water pumps and water treatment plants that supply individuals with drinking water, along with water for washing dishes and clothes, flushing toilets, bathing and other household needs. Therefore it is important to store as much water as you are able prior to the onset of the geomagnetic storm. The least expensive water is right from the kitchen tap. Fill up clean kitchen containers and available buckets with water. Fill up your bathtub with water. Bathtub water can be used to flush toilets and for washing needs. At a bare minimum, you should have enough water to last for three days per person. Generally this will equate to one gallon of water per person per day. A fallback option is to buy bottled water from the stores.
- 7. *Bleach*** – Access to clean drinking water may become a problem during a major blackout. Purchase several gallons of bleach for use in drinking water purification. Obtain only non-scented regular liquid bleach (such as Clorox) to disinfect water. Avoid purchasing bleach that contains perfumes, dyes, cleaners or other additives.

8. Food – Ensure you have adequate supplies of food available that does not require refrigeration or cooking (e.g. breads, peanut butter, jams, small tins of tuna fish etc.). These are foods that let you fix a decent meal without electricity.

9. Can Opener – If you have stocks of canned foods, ensure that you have a mechanical can opener available. Electric can openers will not work without electricity.

10. The Morning Commute – At the onset of an electrical blackout, most individuals will want to return home before nightfall. Their main obstacle will be global gridlock. Electric commuter trains and subways will grind to an immediate halt. Automobile, taxis and bus traffic in cities will be gridlocked due to inoperative traffic lights. Also the volume of pedestrian traffic will increase and spill over onto the streets further blocking motor vehicle traffic. Tunnel managers will close down some traffic lanes within tunnels. Generally, tunnel ventilation systems require an extensive amount of electrical power and as a result many are not connected to electrical backup system. Therefore, tunnel operators will have to reduce the number of cars allowed through at any given time in order to minimize the threat of carbon monoxide poisoning. Without electricity, rail traffic will be affected by inoperative railroad crossing signals and railroad stations blackouts. In large cities, many commuters will face reality and simply decide to walk home with some traveling over 160 city blocks on their journey.

If you commute by subway, train, bus or taxi or if you live or work in tall buildings, then I recommend that you either wear or take along a pair of comfortable walking shoes or sneakers to work. Also carry a flashlight, a couple bottles of water and a small portable radio.

Discuss the potential for an electrical blackout with your children and determine what course of action they should take during a major blackout. It may be difficult to pick up children from school or day care or even communicate with either the school or your children during a blackout. Work with the school and provide them with written directions, if necessary.

11. Elevators – At the onset of an electrical blackout, people will be trapped in elevators, in underground mines, on roller coasters (some dangling from rides in midair), and inside commuter trains. (Some of these commuters will need to be evacuated from trains stopped in tunnels and between stations. It can take more than 2 hours for transit workers and emergency personnel to reach some of these trains. Those stranded in tunnels may be in pitch blackness.)

As a general rule, I advise that individuals should not ride on elevators whenever there is a threat of a massive geomagnetic storm. If at all possible take the stairs. If an electrical power outage of this magnitude occurs, you may be stuck in a dark elevator for a very long time, cutoff from the outside world.

12. Airlines – Avoid flying during a massive solar storm with a similar intensity to the Great Solar Storm of 1859. If you chose to fly, you will expose yourself to higher levels of nuclear particle radiation and the electronics within the aircraft will also be subjected to greater failure rate due to this radiation exposure. The solar storm will adversely affect aircraft communications and navigational signals. On top of this, a major blackout induced by a geomagnetic storm will severely affect operations at multiple airports over vast regions. Aircraft may fly at lower altitudes below 25,000 ft embedding their craft in the shielding afforded by the thicker lower atmosphere and alter their course away from Polar routes to minimize the radiation threat. But the magnitude of this type of solar storm is so great that the threat will be global. So the question here is “How much do you value your life?” It is best to just avoid traveling by aircraft until the solar storm has run its course and avoid this unnecessary risk.

13. Communications – All types of communication (telephones, cell phones, radio transceivers, and television) may be down for awhile. So before you lose communication, call family and friends and let them know where you are and your plans should a major electrical power outage occur. Also try and hunt down a corded telephone that doesn't require electricity to be used as an emergency backup.

14. Radio – Battery powered or hand crank radios are a vital communication/informational link during a major blackout. If you don't own one, I recommend that you buy one. Hand crank radios will continue to operate during a long duration power outage; long after the battery died in other radios. There are a variety of hand crank radios on the market today to choose from.

15. Rechargeable Batteries – In a blackout, it is better to start out with a fully charged set of batteries. Charge all rechargeable batteries (e.g. cell phones, portable computers) that you might need during a blackout.



Figure 1. Etón Model FR-400 Hand-Crank American Red Cross Receiver.

16. Disconnecting Power – Unplug home electronics (e.g. computers, televisions, radios, satellite receivers) as much as possible. Induced voltage spikes during geomagnetic storms may damage electronics. (Voltage transients have been the death of many pieces of electronics within my home. As a result, I am a firm believer in voltage line conditioners/regulators.) It just makes common sense to unplug sophisticated electronics during an extreme solar storm.

If you live out in the country and use well water, then I strongly suggest that you also unplug the power line to the well pump. Deep wells make strong earth grounds and you don't want to take the chance of induced current burning up the pump electronics.

17. Automatic Backup Generators – Some homes, businesses and hospitals have fixed electrical backup generators. Ensure these generators are fully fueled and operational.

18. Aspirin – About 50 years of medical research has shown that geomagnetic storms directly correlate with an increase in heart attacks and strokes. Furthermore these effects appear to be concentrated among the elderly. Anyone over age 35 should take aspirin during the first week following a solar storm. Unless you have a medical condition that restricts you from using aspirin, I think it may be beneficial to take an aspirin a day. The FDA has approved the use of aspirin to reduce the risk of heart attack and stroke in people who have had a heart attack, those who have suffered an ischemic stroke, and also those who have had either stable or unstable angina.

19. Buckets – Strong plastic buckets or pails can be very useful to haul water in the event an electrical blackout affects access to clean drinking water. Consider buying some if needed.

20. Vitamins – During a long duration blackout, access to the wide range of foods may become fairly restricted. Your diet may become stressed and deficient in important vitamins and minerals. I recommend purchasing a three month supply of multipurpose vitamins in preparation.

21. Toilet Paper – One day back in the 1970's, I stopped off at the grocery store on my way home from work. As I entered the store, I noticed something was amiss. The aisles of toilet paper were almost bare and there were a large number of elderly ladies with shopping carts filled with toilet paper in the checkout lane. When I returned to the car, I turned on the radio. There was a report of a major shutdown at a toilet paper manufacturing facility which was leading to a run on toilet paper. The television news that night showed grannies in the checkout lane battling over rolls of toilet paper. The stories of the plant shutdown turned out to be only false rumors. And life returned back to normal.

Toilet paper is a luxury item that we take for granted. Who am I to argue with thousands of grannies who treat it as a staple of life! So in the run-up to a major blackout make sure that you have sufficient

stores of toilet paper in stock to fill your needs. The same advice may apply to feminine hygiene products.

22. Reading Books – During an extended blackout, you may have plenty of spare time on your hands. I would advise picking up a few good books to read or to read to your children. This may be a good family bonding experience. Visit a nearby library or bookstore.

23. Pets – If you have pets, you might want to ensure that you have adequate supplies of pet food available.

24. Cold Weather – Imagine your house or apartment without electricity for weeks or months during the winter. In general, this will also equate to a lack of heat because most furnaces need electricity to operate. In cold climates, during the winter months, this can present a major problem. Individuals will need warm clothing during the day and warm bedding during the night. This may take the form of wearing multiple layers of clothing. If you are not prepared for this possibility, it may be important to obtain additional warm clothing, blankets (preferably down) or sleeping bags rated for the outdoor temperature range you might potential experience in your neck of the woods.

25. Garage Door – During a blackout, the electric garage door will no longer work. Know how to manually disengage the garage door opener. Hunt down the owner's manual if you need to or ask a neighbor for help. If you use the garage door as the main point of entry into your home, make sure you carry keys to your front door.

26. Aurora – Experience the power of a Great Aurora. It is definitely beyond a once in a lifetime event, a wonder to behold for both young and old. Expect an early appearance at dusk and then for it to die down but around 3 o'clock in the morning expect a really great explosion of fireworks to light up the sky. Don't miss it.

27. Power Grid – Several steps are currently employed to respond to moderate solar storms. These protective measures include disconnecting the links between power grids, desensitizing automatic control systems, reconfiguring to provide extra grounding, less switching, fewer large-scale power swaps, and delaying power station maintenance. But these measures may be insufficient for a massive solar storm.

One other step may be needed called load shedding. It has become accepted and in some cases the preferred practice should be to shut down parts of the system to protect the whole system when there is a danger that operators might well lose the whole system. Voluntary loading shedding can produce a major inconvenience, but it also protects all kinds of crucial equipment and makes the restoration of power much smoother and quicker.

If a massive solar storm approaches Earth, it seems logical to place most of our entire electrical infrastructure into a safe mode. It is wiser to take down the power grid in an orderly controlled manner than to allow the grid to be subjected to two days of Geomagnetic Induced Current (GIC) abuse and damage. This would necessitate major blackouts in this country but the damage from a planned blackout will be significantly less severe than suffering major transformer damage that might take years to recover and place back on-line.

At the same time, it may be wise to place many of our nuclear reactors in safe mode. Nuclear reactors require electricity for operation; electricity that does not originate from the nuclear power plant. (The Chernobyl nuclear power plant disaster came about when plant personnel decided to test the ability of the reactor's turbine generator to generate sufficient electricity to power the reactor's safety systems (in particular, the water pumps), in the event of a loss of external electric power.) A controlled shutdown is preferred to a catastrophic shutdown caused by a massive solar storm.

B. Recommended Actions After the Blackout Hits

This section is designed to help individuals get through the first few days of the crisis.

1. *Scope of Disaster* – The scope of the disaster may not be completely known for a several days. This is due to the degrading nature of GIC damage. Electrical power may be restored only to crash a few days later. As the state of the transformers and other critical infrastructure is examined in closer detail, the damage sustained by many elements within the grid will become obvious and then the equipment will begin to fail. After a major geomagnetic storm similar in intensity to the Great Solar Storm of 1859 (Dst of 1760 nT), I feel it is important to not drop your guard for at least a month. The worst may be yet to come. Should the power be quickly restored, I advise you to use this valuable time wisely as a unique opportunity to complete final disaster preparations.

2. *Communications* – Most individuals will be keenly interested in the extent of the outage, the cause of the outage (natural or terrorist) and a prognosis of when power will be restored.

Many will try to call family members or friends, even those in distant cities not affected by the blackout to scope out the extent of the outage. Others will call family members to check on their wellbeing and to coordinate their plans. Even if cell phone service is not physically disrupted, the heavy increase in call traffic can quickly overload circuits. Expect cell phones to go down or work only intermittently. In many cases, mobile cell phone towers only have emergency backup power for a few hours. Cell phones will also die as their batteries drain down.

Landline telephones run off of the small DC current that the phone company sends through the lines. But modern phones have so many gadgets that most need a separate AC power adapter to run them. These phones are so poorly designed that they cannot operate at all when there is no AC current. For example, most household portable phones are useless without power to their base set.

In general, access to the internet is unavailable because most computers are inoperative due to a lack of power.

At the onset of the blackout:

- Expect almost all of the FM radio stations to be initially knocked off the air. Many of these stations will return over the next hour as emergency backup generators kick in. Portable radios and car radios are a vital key in communicating an early assessment of the blackout.
- Expect pay phones to continue to work but also expect long lines waiting your turn. You may have better luck reaching someone on the office phone before you leave work.
- Expect land-line telephones to continue to work, but you must have a telephone that does not have a separate power cord. A small UPS system can power many modern telephones at the beginning of this emergency.
- Expect laptop computers with dial-up modem connections to generally continue to operate in an electrical blackout at least until their computer batteries drain down.
- Expect cell phones networks to be jammed. But it may be of interest that text messaging appears to operate on overloaded cell phone networks during the onset of a power outage.

3. *Traffic* – Traffic signals will fail during an electrical blackout. If you approach an intersection where the traffic signals are not functioning, remember that the intersection is to be considered a four-way stop. Always yield to the right, and keep in mind that during a blackout, normal traffic patterns will be disrupted. Drive defensively and remain extremely alert, especially if you are a pedestrian.

At clogged intersections, private individuals will sometimes step forward and direct traffic in order to relieve congestion and gridlock. In some cases, passing police officers will distribute fluorescent jackets to these noble souls. Drivers and pedestrians will generally follow their instructions, even though they are not traffic officers. When private individuals try to unclog traffic at intersections by directing traffic,

respect their orders as if they were traffic police. It is in everyone's best interest at the onset of a major blackout to keep traffic flowing.

4. Travel – If a great solar storm causes extensive damage to the electrical power grid and after commuters are allowed to return home, city/states should minimize driving by imposing an emergency no-drive order for automobile traffic during the initial couple days of the blackout. This is:

- to prevent gridlock for emergency personnel (fire fighters, ambulances, electrical/water infrastructure repair,
- to conserve valuable fuel until the depth of the power emergency can be adequately assessed and a timeframe for repair can be determined.

As much as possible, I encourage individuals to stay at home. This is your primary shelter. After the no-drive order has been lifted, consider driving on roads that are not as heavily traveled. Take alternate routes. This will reduce traffic congestion and delays caused by non-functioning traffic lights.

5. Accidental Electrocutation – During massive geomagnetic storms avoid contact with long metal conductors (e.g. downed power lines, railroad tracks, pipelines) because inducted voltage from the geomagnetic storm can cause accidental electrocution.

If you use a portable electrical generator and you decide to power directly into the house, you need a transfer switch or a manual disconnect at the main; otherwise, you may accidentally electrocute the utility repairman working on the power lines trying to restore the power to your home.

6. Emergency Calls – Many city 911 emergency call systems will fail due to heavy call volume. Do not call 911 unless it is a true emergency, a life and death situations. You will be surprised by all the ridiculous reasons why people call 911 in a crisis. Call volume increases dramatically. This binds up the emergency response system depriving individuals of who truly need emergency help.

7. Reduce Surge Load – During an electrical power outage, turn off all major appliances such as washers and dryers. Unplug all sensitive electronic equipment like television sets, VCRs, microwaves and computers. This reduces the electrical demand when the power is restored and reduces the chance of damage caused by electrical surges. Leave one light turned on so you will be aware of when the electrical power is restored.

8. Water – In a crisis, water is life. An electrical blackout may impact the operation of the large city's water pumping stations and water treatment plant. Many city water plants are designed with huge backup standby generators to ensure operations continue during a major blackout. But these backup systems can fail.

Smaller cities may be more vulnerable to loss of water during a major blackout.

Private water systems built around streams, springs, and wells that use electric pumps will quit working the moment the electricity goes off.

After the blackout begins, individuals if they have not already done so should fill all available household containers with drinking water from the tap. There will be some residual head pressure in the water supply and you should use this to your advantage.

9. Food – Consume perishable food in your refrigerator and freezer first. Leave the doors closed on your refrigerator as much as possible to help keep the food inside cool and fresh longer. Without electricity perishable food will quickly spoil due to lack of refrigeration.

10. Cooking – In general, during a blackout, modern indoor gas and electric ranges and ovens will no longer work. Old gas appliances before the invention of the electric igniters were designed to be lit by matches and will continue to function. Once electrical igniters were integrated into appliances, they initially had a backup in the event of a power failure which allowed them to be started with a match. This would allow cooking on the range and some heating of the home (although the blowers would not

function to circulate the heat). But in general today's ovens and ranges are no longer designed for match starting. Refer to this website: http://www.appliance411.com/faq/gas_range_ignition_systems.shtml

There are many alternatives to indoor gas or electric ranges. The most common is the outdoor barbecue grill. Outdoor barbecue grills should never be used indoors. They are designed for outdoors to preclude carbon monoxide poisoning and the potential for house fires. Carbon monoxide fumes can quickly turn that blackout meal into your last supper.

11. Fires and Carbon Monoxide Poisoning – There is a natural tendency to use candles as an emergency light source in a power blackout. Candles can accidentally fall over and start house fires. A house fire without means to call the fire department and without sufficient water to put it out will not only be fatal to your home but also may consume entire blocks of tightly packed houses or apartments. [For example, during the Indonesian 7-hour blackout of 20 August 2005, candles were responsible for 6 fires in Jakarta alone.] I recommend using flashlights during a major blackout. If you chose to use candles make sure they are placed on a large non-combustible surface away from other combustibles such as curtains. Also don't run your car in an enclosed garage to keep warm. Use some common sense about these hazards.

12. Frozen Water Pipes – If the blackout occurs in the dead of winter in a cold climate; the loss of electricity might prevent you from heating your home. Over the course of the next several days, the structure will lose residual heat and the water pipes may begin to freeze and burst. This can cause considerable damage to a home. Broken pipes can flood your home, especially if you are not around, when water is restored and the pipes unfreeze. You will need to assess your particular situation. The blackout may have taken down your city water plant and therefore your water lines may not be providing you a service. If you feel frozen water pipes are a real threat in your circumstance then you have a couple steps that you can take to minimize the threat. First, you could turn off the water main going into your home and drain your water lines. You will also need to drain any in-line water tanks and your water heater. You might need the services of a professional plumber to accomplish this. Some of your drain pipes (toilets, sinks and bathtubs) have built in traps that hold water. You can treat these traps by pouring in a cup of Recreation Vehicle (RV) non-toxic drain antifreeze into each drain to prevent these specific pipes from freezing. (Never substitute toxic automobile antifreeze for this purpose.)

13. Climate Extremes – If in the middle of a very hot summer, seek relief in cool places and don't overexert your body. If in the middle of a cold winter, dress to keep warm. You need layers of clothing to insulate from the cold air but not so much that you overheat. Head gear, gloves and warm socks helps retain a large percentage of body warmth lost through your body's extremities. It's a lot easier to stay warm than to warm up from being chilled.

14. Toilets – If the city's water plant fails, there will no longer be city water available to flush the toilets. Over the next few days, the stench can drive individuals from their primary shelter, their home. Haul water from available ponds, lakes, streams, rivers, swimming pools or rain water to flush toilets. Manually pour a bucket of water into the bowl until it flushes. Flush used toilets at least once per day. Keep your house livable. It is the best shelter you have. If the blackout also takes down your city's waste treatment plant, you may be forced to discontinue using your toilets.

15. Tall Buildings – Tall buildings will be particularly vulnerable to the effects of an electrical blackout. Elevators will not work. The lack of natural lighting in hallways and stairwells will make them pitch black. Even stairwells equipped with emergency lighting will go dark after about an hour as the batteries drain down. Climbing stairs in the dark can be very risky and dangerous. The water tank on the roof will quickly empty and not be refilled because the buildings water pumps will shut down. As a result, individuals will be unable to flush toilets. The air conditioner will be inoperative. Climbing long flights of stairs will be strenuous and hauling supplies of food and water back to rooms or apartments will be hard work. The buildings will be more susceptible to fire hazards because automatic fire-suppression sprinklers will no longer have available water.

Relocate to the lobby areas of large hotels. For those individuals living in tall buildings, move in with others in first/second story accommodations if possible during an extended blackout.

16. *Neighborhood Watch* – Meet your neighbor and form neighborhood watches. It is easier to deal with emergencies as a group than individually. Check on elderly neighbors or anyone who may have a medical condition that requires the use of medical equipment that is electrically powered.

17. *Sunblock* – A major solar storm will severely deplete the ozone layer in the upper atmosphere worldwide. The ozone will regenerate naturally over the course of a couple years. The thinning of the ozone layer will increase the penetration of ultraviolet (UV) radiation resulting in increased incidences of sunburn, skin cancer and cataracts. I recommend the routine use of UV blocking sunscreen lotion and the use of UV blocking sunglasses when outdoors for a period of 2 years after a massive solar storm. I have recently communicated with a young anthropologist in Mexico. She related how many Mexican Indians were getting sunburned for the first time in their lives. They lived their whole lives outdoors and this is the first time they were feeling its effects. I explained that large solar storms of 2003 and 2005 depleted large amounts of ozone from the upper atmosphere and as a result ultraviolet radiation was penetrating down to the Earth's surface to a greater degree. We probably failed to notice this observation in the U.S. because we tend to use these products anyways when we work outdoors or go to the beach.

18. *Critical Computer Infrastructure* – Some organizations had backup power for their critical computers but rarely cover backup power for the air-conditioning units required to cool this infrastructure. Therefore these systems will be prone to failure several hours into the blackout. As a stop gap measure, room doors should be opened and fans should be used to circulate air to reduce overheating. Also any piece of equipment that produces heat that is not absolutely essential should be turned off, including many computer monitors.

19. *National Guard* – From an organizational perspective, when a major long-term blackout strikes, it is time to call up the National Guard. The National Guard and the military can play a pivotal role during this type of disaster. They have access to large water purification systems and large motor generators. They are mobile and can operate anywhere and everywhere. They have strong communication systems, both mobile and fixed. And they can provide security and order when needed.

20. *Riots* – In general, the majority of individuals will act very responsibly during a crisis. They will lend a helping hand where needed. But there are always a few bad apples in the lot. At the immediate onset of a major blackout, I recommend local government officials aid two categories of shop owners (gun stores, liquor stores) to relocate their wares to safer long-term storage. Often these stores are the first targeted for looting and quickly become the raw fuel from which riots and other mayhem evolve.

21. *Blame Game or Moving Forward* – Currently, the United States has an electrical power network that has very little reserve capacity. In most cases, we as a nation have stonewalled the modernization of our electrical power generating plants and infrastructure. Across the country, the zoning and permit process for new construction has stretched into an expensive, decade long ordeal. In the past few decades, our populations have increased and much of this growth is centered in large major cities. We have forced our power grids to move huge amounts of electrical power over very large distances in order to meet current everyday electricity demands. At the same time, we have reduced our safety margin of extra available power. This has caused our power grid to become very vulnerable to the effects from a massive solar storm. Transferring electrical power over very long transmission lines invites equipment damage & major electrical blackouts.

To minimize this threat, electrical power generator plants should be located near the large population centers that utilize this electricity. That would shorten the distance between the power generators and the power users providing enhanced power network survivability during a large solar storm. We have been led by environmental activists to believe that our nuclear plants are unsafe and an unacceptable threat. But in general, these fears are unfounded. Modern nuclear power plants are very efficient at producing electricity and they also have a very good safety track record. If you want to prevent these blackouts from ever happening again, break the logjam that prevents the construction of new nuclear plants. Eighty percent of the electrical power in France is supplied by nuclear reactors. Sweden derives 50% of its electricity from nuclear energy. I recommend the U.S. place Generation III and III+ nuclear plant construction on the fast track. I also recommend we invest significant research dollars into the

development of Generation IV Nuclear Reactors. I recommend that we break the logjam that prevents upgrading the grid of long-distant high-voltage transmission lines and that the design of these new lines incorporates DC transmission using back-to-back electric buffer valves at each end. I recommend that we as a nation mandate electricity providers to incorporate transformer designs that are resistant to solar storms. They exist! Why must we be held hostage to the next Great solar storm?

In the aftermath of a great disaster, generally the government's first response is to study the problem to death. They commission a committee to investigate the root cause. In this case, we already know the cause; it is a known weakness in our electrical power grid, a vulnerability of the electrical grid to a massive solar storm. And we already have a fairly good idea on how to correct it. What we need is an action plan that will correct this weakness and then the will and resolve to make it happen.

We do not need an investigation study lasting years to apportion blame. This produces a delay in response. This delay serves to allow the electricity providers to minimize and possibly eliminate costly infrastructure modifications required and to pursue unburdening themselves from their financial responsibility by shifting the cost of modernization onto the government. This delaying tactic should not be tolerated.

Our neighbors to the north, Canada, are especially vulnerable to this solar storm threat. After being clobbered several times in the past, they have implemented a number of very innovative design approaches to dealing with this GIC threat. We should study those changes, especially those that stand up to a real threat and apply them to our own electrical infrastructure.

22. Relocation – Generally when I think of disaster evacuations, I think of hurricane evacuations which occur prior to a hurricane making landfall. But in the context of a massive solar storm that takes down the power grid, it will be very important for city, state and federal government to manage the voluntary post disaster evacuation. If the power grid is damaged and restoration will take months or years, then most individuals will consider relocating their families to regions unaffected by the blackout. If this occurs in an unordered manner, then individuals might fling themselves into far greater peril and calamity. Many individuals will simply get into their automobiles and attempt drive out. But gridlock will dramatically slow down their progress; they will run out of gas along the highway; and there will be no fuel available for them to continue their journey. They will be stranded along the roads and byways of America begging for help. If cities are to be temporarily abandoned, it should be done in a very controlled and ordered fashion.

The first step is to delay any evacuation for a few days until the full extent of the infrastructure damage is known and a prognosis of recovery is assessed. It may be possible to arrange for backup generators for the service stations along the main exit corridors (highways) leaving the cities and the regions. At least then individuals could leave without the threat of becoming stranded in the middle of nowhere.

I feel any evacuation should be voluntary because homeowners have much more of a stake in protecting their homes and their neighborhood than governmental bureaucrats. Some individuals are prepared for any disaster that may come their way and are perfectly capable for surviving months without any outside assistance. I also feel it is important for people to have a home, a community and a city to return to after the crisis is over. Deploying National Guards to large cities, with a shot-to-kill order on looters and arsonist, might go a long ways on minimizing this type of damage. The government should not interfere with or harass neighborhood watches protecting their neighborhood.

Individuals and families that leave should have a destination to travel to and someone who can take them in until they get settled. Available housing in non-affected blackout regions may be very limited. When foreigners visit or immigrate to the United States, generally we have sponsoring families that agree to take them in and watch over them. They have a predetermined destination before they leave their home country. In this type of disaster, the same rule should apply. These sponsoring individuals can be friends and extended family members or they may even be total strangers willing to open their doors to someone in need. I feel the government has an important role to play in this evacuation process.

23. Conservation – Many people will relocate during a long-term blackout to unaffected regions. As a result, there will be a need for greater energy conservation due to the influx of these additional people and

their energy needs. Otherwise this added electrical load will overtax the power grid in these unaffected regions and cause further breakdowns and extend the blackouts to the rest of the nation.

IV. Proactive Approach – Individuals

IF major elements of the electrical power grid are severely damaged by strong GIC currents during a massive solar storm, the recovery time may be measured in months and years. Many individuals have experienced power outages when the grid fails. These are generally restored in a few hours or days. But a massive widespread blackout affecting many critical components of the grid simultaneously is something that has never been experienced before.

Disasters are known to strike whether it be the normal variety (e.g. major winter storm, earthquake, and hurricane) or the rarer variety (e.g. asteroid/comet impact, supernova). Many of the guidelines or approaches cited in this section deal with disaster preparedness and apply to a broad range of disaster categories. So although this preparedness plan deals with one type of disaster (massive solar storm leading to an extensive prolonged power outage), its scope can be much broader. Remember the boy scouts motto of “Be Prepared”.

Basics preparation represents the checklist of life. What does a human being need to survive, short and long-term? Air, water, shelter, and food.

The proactive component of the disaster preparedness plan addresses preparation for long-term survival without several elements (clean water, food, sanitation, electricity etc.) Some of the preparations considered include: manual filtration systems for purifying the water, sanitation systems for minimizing contamination to drinking water supplies, grain storage and processing for food, and general survival advice.

The following is my personal recommendations. There are many solutions to surviving this type of disaster, not just a single approach. Some choices will be better than others. These are mine.

A. Water

During an extended electrical blackout, water storage and treatment facilities may experience outages. City water may become contaminated or unavailable. During a crisis of this type, the ability to store water and the ability to treat water can sometimes mean the difference between life and death. Individuals can only survive for approximately 3 days without drinking water.

1. Storage – There are many types of containers that can store drinking water. The following are three types:

The first is a 5-gallon water container that can be obtained from a used Army surplus store. Refer to Figure 2. It is rugged and ideal for hauling and transporting drinking water.

The most common means for storing emergency water in the U.S. is 55-gallon food-grade plastic drums. Refer to Figure 3. There are two types; one has an open head design with a removable top secured with a ring clamp, the other has a closed head. Either type is workable. Some individuals will store water year round. They fill up these drums with water and treat it with chlorine for long-term storage and store it away in the basement or closet for any emergency. But if the barrels are stored outside, in an unheated garage or outbuilding in cold climates, the water can freeze and rupture the drums. Therefore it is important to protect these barrels



Figure 2. 5-Gallon Water Container



Figure 3. 55-Gallon Plastic Drum – Closed Head

site where clean drinking water is available, fill up the container and drive it home. These containers come in different sizes. They compress down nicely when not in use. The company also manufactures a 3' x 8' 150-gallon Aquatank II container that is more ruggedized than the original Aquatank containers. I would recommend one of these.

2. Treatment – One of the basic human survival needs is water. When the Katrina hurricane struck New Orleans, there was a severe shortage of drinking water. If the drinking water was not trucked in, many individuals would have perished or likely become very sick. But vast quantities of water were readily available all over New Orleans, only the water was highly polluted. Manual filtration systems and approaches are available that could handle even this level of polluted water.

Several methods are available for purifying ground water from rivers, streams, lake, ponds and rainwater and contaminated tap water. One method of treatment is boiling water at a rolling boil for 3-5 minutes. Refer to <http://www.sandiego.gov/water/operations/leaks/disasterdisinfect.shtml>

But a lack of electricity may make it difficult to follow boil water advisories. Another method is to filter the large contaminants from the water using bleached cotton cheese cloth and then treat the water with liquid bleach to kill the dangerous bacteria. For this reason it is a good approach to store several bottles of bleach and a roll of cheesecloth in the event of an emergency. Cheese cloth can be obtained from a sewing supply store such as Jo Ann Fabrics. Other water filtering alternatives include coffee filters, paper towels or a cotton plug in a funnel. Use only non-scented regular liquid bleach (such as Clorox) to disinfect water. Avoid using bleach that contains perfumes, dyes, cleaners or other additives. Read the label. Household bleach is typically between 5 percent and 6 percent chlorine. The amount to add is 1/4 teaspoon of regular, household bleach for each gallon of water. This works out to 5 drops for a quart (or liter) of water, one teaspoon for 5 gallons, 11 teaspoons for 55 gallons. (This applies to surface ground water, cloudy water and very cold water; otherwise if the water is clear, then only half that amount of bleach is needed for disinfecting). In small containers, shake the container after adding the bleach and allow it to sit for 30 minutes before drinking.



Figure 4. 200-Gallon Aquatank Water Storage Container

from extreme cold. Others will store the barrels empty and fill them as an emergency approaches. If you purchase a closed head barrel, I would recommend you also purchase a hand operated water pump stroke such as the Rieke Corp MR50XL to make it easy to extract water from the barrel.

Another type of storage is an Aquatank water storage container. Refer to Figure 4. This photograph shows a 200-gallon water containers, 4' x 8' in size; one that fits on the bed of a pickup truck. It gives the ability to drive to a

I purchased this Katadyn Pocket Filter in 1985. It has a 0.2 micron microporous ceramic filter element that can filter water from rivers, streams, lakes or ponds and make it bacteriologically acceptable drinking water. This item is still in production today. I think it says something for the quality of a product to survive the test of time. The filter will produce about a quart per minute of drinking water. The filter can produce about 13,000 gallons before it needs replacement.

Big Berkey is a gravity fed water filtration system. It uses 4 ceramic filter elements that reduce 99.99% of particulates, cysts, parasites and pathogenic bacteria from water. It will process 21 gallons of water per day. Figure 6 is a photograph of Big Berkey and Figure 7 shows the ceramic filters used in this system.



Figure 5. Katadyn Pocket Filter



Figure 6. British Berkefeld, Model SS Big Berkey



Figure 7. Ceramic Filters used in British Berkefeld

In a crisis, many individuals will not have prepared properly for their drinking water needs. Often times ground water sources and tap water sources will become polluted, which can lead to sickness, disease and the potential for epidemics. Ceramic water filters are expensive and few members of our society will have the foresight to purchase one. I felt there has to be a better means to filter drinking

water in an emergency. I visited my local plumbing supply store and designed & constructed a high volume Gravity Feed Water Treatment System. This system is designed to treat 100,000 gallons of ground water (from rivers, streams, ponds, lakes, rainwater, contaminated tap water) into drinking water at a rate of approximately 130 gallons per hour during a crisis, enough water for a small town. Refer to <http://www.BreadAndButterScience.com/GFWTS1.pdf>.⁴

Other water treatment methods are described in Lifewater International, "Water Treatment" at http://www.lifewater.org/resources/water_treatment.html#WT.⁵

B. Food

During a crisis, food will quickly disappear from store shelves. Because trucking will be affected by a fuel crisis brought on by a major blackout, because stores will be dark from lack of lighting and because the cash registers, credit card and banking systems will be down, store shelves may not be restocked and many stores will shut their doors. Stores that remain open will be greeted with long lines and the need to maintain crowd control.

Food is another basic human survival need. Humans can live about a week without food, less in cold weather and limited water. In an emergency, stockpiling food, even enough for 5-7 days, saves having to forage, hunt, buy, barter, or trade for it. Or worse! Hunger strips away the resolve of people unaccustomed to its grip. We are accustomed to obtaining food from grocery stores. These assets are insufficient and will be quickly exhausted.

In a proactive approach, individuals and families should prepare for emergencies, even long-term emergencies. Food should be one of the items on the top of everybody's list.

Guidance: The majority of food individuals will need to survive a 3-months or longer disaster will not be food that they have in storage. Rather it will be grains, especially feed corn, stored in grain silos across the United States. I strongly recommend individuals possess the means to process this corn into flour.

Individuals and families should store dried wheat, rice, beans and other grains and legumes as a staple food supply to cover their needs for at least a period of three months. This is relatively inexpensive, long-term shelf life food if properly packaged and stored.

Only after these first two items are accounted for should individuals and families turn their focus to adding variety to their meals by including properly packaged freeze dried food. This is relatively expensive, long-term shelf life food.

Most of the world lives on grass seeds; wheat, oats, rice, millet and other cereals.⁶ The United States farmers produces vast quantities of food. In the 2005/2006 trade year, the U. S. farmers produced 63.2 million tons of wheat, 7.8 million tons of rice and 329.3 million tons of coarse grains (corn, barley, sorghum, oats, rye, millet and mixed grains). This production equals approximately 400 million tons.⁷ The majority of grain produced in the United States is in the form of corn, a natural choice for long-term emergency food source because of its abundance. Most of this grain is currently used as livestock feed.

The minimum daily requirement for food is 2,100 calories per person.⁸ Grain meal provides between 1200-1700 calories per pound. In general, one ton of grain is required to supply the minimal needs of one person for a period of three years. Sufficient grain exists in the U.S. at any given time to support its population for approximately 3 years provided the grain can be protected from moisture.

Individual and families may decide to purchase grain supplies directly during this type of long-term natural disaster. This is really a backup should their food stores run out. Grains in this nation are stored by farmers and by organizations such as farm cooperatives, and Feed & Grain stores. The quickest method to obtain a large quantity of grain is for an individual to drive up to a farm coop and have them load bags of grain onto the back of their pick-up truck. A fifty-pound sack of corn was running \$6.10 a few years ago at the local Feed and Grain the last time I checked. Large shipments can be delivered to any destination in bulk form. In my locale, a ton of corn could be delivered to my home for \$104 with a \$1 per mile delivery fee. Whole corn kernels are recommended rather than cracked corn to extend the

shelf life and to facilitate the cleaning the corn prior to processing. Also seed corn should be avoided because they may be pre-coated with harmful chemicals (insecticides, herbicides).

Individuals and families should store some food for whatever disaster might come their way. What amount should be stored? I feel a three-month supply is about the right amount. This provides a buffer time. What form should the food storage take? Shelf life is a major issue. Many forms of food storage have short shelf lives and require a meticulously tracking and food stock rotation program. For that reason, I recommend storage of basic food staples in the form of dried wheat, rice, beans and other grains and legumes. Refer to Figure 8. Emergency Essentials at

www.BePrepared.com is a good source. Send away for their catalog because I find it difficult to maneuver through their online store website. The grains I recommend are in 6-Gallon SuperPails. These grains are stored in a metalized bag to keep moisture and odors out. Prior to sealing the grains in a bag, an oxygen absorber is inserted. Oxygen absorber packet chemically bind and remove oxygen from inside the bag. Air contains about 78% inert nitrogen and 21% reactive oxygen, leaving about 1% for the other gasses. The oxygen is absorbed, leaving about 99% pure nitrogen in a partial vacuum. This will keep the grains fresh for a very long time. The bags are inserted in six-gallon SuperPails. This protects the metalized bags and also keeps insects, mice and other vermin out. Food in this form stored in a cool environment will last 20+ years. Thus you can avoid the problem of constant food rotation. The SuperPails are stackable and fit easily inside a closet. I found the cost of this food comparable to the cost at a grocery store. I recommend rice, beans, peas and lentils because of their ease in preparation (place in boiling water). Wheat, spelt, barley and oats will generally need to be ground to make flour and then baked to make bread. I have bought and used this product and give it my thumbs up.



Figure 8. 6-Gallon Superpail of “Spelt”, Gamma Lid Removed



Figure 9. Freeze Dried Chicken

I also recommend purchasing a few Gamma Seal Lids. Once you pop the top off a SuperPail, you will need to reseal it between daily uses. Gamma lids provide a quick on-off airtight sealing lid.

Spelt is an ancient grain. Its origin goes back 8,000 years. It is hardier than wheat. Insects find it more difficult to penetrate the shell of this grain; therefore farmers growing this product do not need to use insecticides. It is a little harder to grind into flour than wheat. But most hand and electric mills will handle it just fine. It makes a very delicious hearty bread that has a nutty flavor. I could easily envision calling this bread, “Hobbit” bread.

It is also advisable to purchase some freeze dried food to add variety and taste to the meal. Nitrogen (nitrogen back-flushed with less than 2% residual oxygen) packed freeze dried food in metal cans have a proven shelf life in excess of 30 years. This is relatively expensive food.

I would shy away from Meal Ready to Eat (MRE) because they only have a shelf life of approximately 8 years. MREs are also fairly expensive. I would also shy away from storing commercially canned food in metal cans. The general guidelines from the USDA are high acid canned foods (fruits, tomatoes, pickled products) have a shelf life of 18 to 24 months. Low-acid (meat and vegetables) have a shelf life of 2-5 years. In general, food in metal commercial cans do not last nearly as long as food in canning jars. And the metal cans used today in my opinion are not nearly as durable as those of yesteryear.

Many individuals out in the country can their own food. So the question comes up, what is the shelf life for food canned in glass canning jars. I have eaten beans from canning jars that we canned 25 years ago. Others have eaten canned pickles and venison over 30 years old without any ill effect. The U.S. Army has found that canned meats, vegetables and jams “were in excellent states of preservation” after 46 years. Some common sense is due here. In many cases, if the food in glass canning jar goes bad, it will pop the lid. This food should be discarded. If mold forms on the food or if the food gives off an offensive strange odor, discard it. If in doubt, recook it at boiling temperatures.

C. Food Preparation & Cooking

The primary source of long-term emergency food in the U.S. during a major crisis will be grains (especially corn). It may be an unreasonable assumption that these grains will be available in processed form. As a result, I strongly encourage each individual and family to possess the ability to process the basic lowest denominator of emergency food, feed corn. This may not be as easy as it seems.

I decided to run an experiment and tap into this source of nutritious emergency food. After all, how difficult could this be? I traveled to the nearest Grain and Feed Store and purchased a fifty-pound sack of cracked corn. (I mistakenly thought cracked corn, since it was already broken in pieces, was easier to process.) I soaked a handful of corn in a pot filled with boiling water to soften it up. After two hours it was still as hard as stone. Then I soaked the corn overnight in room temperature water. In the morning it was still extremely tough. I took a few pieces and tried to chew them. After about 5 minutes my saliva softened the pieces a little. I have powerful jaws and you need them if you try to eat corn this way. Also it is good to have a resident dentist on call 24-hours a day. So far I would categorize my experiment as a miserable failure. I was getting desperate. I took some corn into the garage, found an old used heavy metal pot, took out my hand sledgehammer and began to work. After about 30 minutes, I reduced a cup of cracked corn into fine powdered corn meal. Success! All told, I probably burned more calories than what was present in this corn. I went back into the house and used the corn flour to make tortillas. The end-product looked more like a UFO shaped pancake. I ate some. It was edible. I gave some to my youngest daughter, Carrie. She ate it and afterwards complained that I was trying to poison her.

Lessons learned:

- I found it extremely important for an individual to purchase a reliable and durable hand operated grain mill if they ever need to tap into this basic food source. I purchased a Country Living Grain Mill and a Bean/Corn Auger Accessory. Other examples of good mills are a Heidelberg Grain Mill, Family Grain Mill, and Silver Nugget Mill. All of these may be a little pricey but the quality is there. Whatever you purchase must be capable of grinding corn. That is why the optional Bean/Corn Auger is a requirement. The U.S. produces considerably more corn than wheat. I do not recommend an electric grain mill because it's a little difficult to operate during a blackout. Also it would be beneficial to have an extra set of grinding plates because the plates will wear out over time. I feel a reasonable goal is 3 years of operation without access to spare parts.
- Purchase only whole corn, not cracked corn. The cracked corn has particles of dirt and other residue intermixed which is difficult to remove. But with whole corn, you stand a better chance of cleaning the corn before you grind it. Also whole corn is more difficult for the critters to consume which will help with storage.
- Purchase a cast iron tortilla press. It is better to make a tortilla that looks like a tortilla otherwise you children will look at you funny during meal-time.

I had a conversation with a close friend, Maria Crays, who made tortillas from scratch and remembers how it was done back in the old days in Mexico. Corn meal is too brittle to be fashioned into tortillas. The following method for making corn tortillas was used in Mexico over a century ago.

How to Process Corn into Tortillas

- * Mix ½ cup of lime with ½ gallon of water.
- * Place one gallon of dry corn kernels in a large pot and add the limewater until the corn was completely covered.
- * Place the pot onto a fire and bring the corn/water to a boil. Slowly cook the corn for approximately 30 minutes until the outer skin is soft enough to peel off.
- * Take the pot off the stove. Add more limewater to completely cover the corn. Set the pot aside overnight.
- * In the next morning, drain the limewater from the pot and rinse the corn with clean water.
- * Coarse grind the corn in a hand grain grinder.
- * Take the ground dry paste and add water.
- * Re grind the moistened paste in the hand grain grinder set to fine grind.
- * Take the fine paste and shape them into balls about half the size of an egg.
- * Use a tortilla presser to make flat tortillas.
- * Fry the tortillas on a fry pan. No oil is required.

This then lead to a conversation about the source for lime. One source of lime is Pickling Lime that may be purchased in grocery stores. This lime is food grade but may contain salts and anti-caking agents. In an emergency situation, lime is a common building material. It is used in cement construction and can be bought in large bags at a building supply store. Ag-lime can also be found in fertilizer stores. These types of lime are coarser. They are an industrial grade. In addition to lime, it may contain some heavy metals, some combustion byproducts, and some fly ash.

In Mexico, lime was manufactured from limestone. The method used to manufacture lime in the small villages in Mexico during the 19th century is as follows:

- * Dried cow dung was collected and placed on the ground to form a circle.
- * A layer of limestone was placed over the layer of dung.
- * Another layer of cow dung was collected and placed over the limestone.
- * Another layer of limestone was placed over the dung.
- * This process was repeated until a large mound was formed.
- * This mound was set on fire.
- * The limestone would heat up until it was white hot.
- * The stones were collected and placed in a burlap bag.
- * Cold water was poured over the burlap bag, and the hot rocks exploded into a fine powder of lime.

Other types of fuel, such as wood or coal, could be used to manufacture lime. In addition to tortillas, corn meal can be processed into cornbread, muffins.

I have described one of the lowest basic denominators for surviving a long-term food crisis. I believe the U.S. has sufficient grain supplies to carry us through a major food crisis lasting up to 3 years. In a long-term crisis, many grains will need to be diverted from animal feed into cornmeal and flour. This may require thinning our herd of livestock and resorting to a bland diet for a few years. But it is far better than the horrors of starvation.

I suspect a food crisis arising out of a massive blackout will be short-lived because the railroads and trucking infrastructure will recover quickly. I wanted to start here with the basics because; this is the final denominator. Since this type of disaster is easier to recover from than other types of cataclysms such as nuclear war or a large asteroid/comet impact, I believe access to food will not be as significant a long-term problem during this crisis as compared to others.

1. Grain Mill – Manually operated grain mills can be extremely useful in a long duration disaster.

Figure 10 shows a hand operated grain mill. I recommend this model because it can also process corn. Make sure that you also purchase the optional stainless steel corn/bean auger (also pictured) when you purchase the mill. Our country produces an abundance of corn. In a long-term disaster, this nation will rely on corn for our very survival. I feel it is essential for individuals to have the tools to convert this corn into flour.

Wonder Mill is an electric grain grinder. It requires electricity to operate, but if you have access to a portable generator, the mill can grind around 10 cups of wheat into flour in about a minute. This is enough flour to make a couple loaves of bread.

I enjoy making bread. Actually that's not quite true. I enjoy grinding the grain to make the bread and



Figure 10. Country Living Grain Mill

I enjoy eating hot bread right out of the oven smothered in butter. But I let my wife make the bread. She is a lot better at it than I am. Mine would probably turn out looking strange or weird like a flat flying saucer and my kids might make funny faces while they ate it. In a true emergency, since I have a portable electric generator, I have the luxury of taking the easy way out and grinding my grains electrically using my electric Wonder Mill rather than by hand.

Another use for flour is to manufacture fresh pasta. In that case a manually operated extrusion pasta maker would be desirable.

Figure 11. Wonder Mill

2. Cooking Stove – I have heated my home solely with firewood for 30 years. I have tens of thousands of trees on my 30 acres. I have an ample supply of firewood at my disposal. Therefore in this type of disaster, I would turn to wood as my source of fuel for cooking during this type of emergency. In constructive emergency planning, everyone should give some thought to the question of a backup cooking source. Most individuals have backyard grills, but how long will the charcoal or propane tanks last. And then what? Some individuals live in areas with abundant firewood, other in areas of abundant coal. These are good long-term sources of cooking fuel. Some areas have



Figure 12. Volcano II Collapsible Stove, Model Number 20-200



Figure 13. Collapsible Optimus Nova Stove by Brunton

abundant sunlight. But others do not have those options. For those individuals, I would recommend purchasing a very efficient stove. This is the type available in a professional camping/hiking store. That way at least you can efficiently meet your cooking needs with a minimal amount of stored fuel. A few gallons of fuel could last you several months.

This Volcano cook stove is designed for use with cast iron Dutch ovens. It runs off from charcoal, wood or propane. It is nice to find a small portable stove that is designed to operate using firewood. It will even run on twigs and branches. This unit is also very portable. Pull on handle and it unfolds in the middle and the legs

come out and lock into position. Lift by the bottom and it folds up for transport almost like magic. <http://www.aaobfoods.com/volcanostoves.htm#top>

This Optimus Nova cook stove is a very fine multi-fuel expedition stove. It runs off from white gasoline, kerosene, diesel fuel, jet fuel and even rape seed fuel. It will even work off gasoline although they don't recommend using it. One fueling of 15.5 ounces will last approximately 2 1/2 hours. It collapses down very nicely fitting into a small pouch.

This cowboy campfire cooking setup in my opinion is overly expensive, but if you have the firewood available and want to turn a disaster into a replica of early cowboy



Figure 14. Campfire Cafe, Cowboy Cookware by Johnny Mix

campfire experience, this is the only way to go. This is something the grandkids will remember their entire lives.

If you live in an area with plenty of good sunlight, then a solar oven might be the ideal cooking stove. One example is the Global Sun Oven.

<http://www.survivalunlimited.com/solaroven.htm> It cooks within a range of 250 - 400 degrees F.

A simple home gas fireplace might be useful in this type of emergency because most do not require any electrical power. Although not very efficient in providing warmth to a home, it might allow you to cook your meals during a major blackout. The grill from an outdoor grill or the grill from your oven could be fashioned into a cooking surface in order to cook food. Cement blocks or bricks could be used to hold up the grill. This could allow you to cook using pots and pans. If you take this option exercise care to prevent injuries due to burns and prevent house fires.

3. *Cast Iron Cookware* – Cast iron cookware has been part of our American tradition since the

Mayflower pilgrims set foot on our shores. Through the years; colonials, explorers, mountain men, settlers, cattlemen, loggers, and gold miners have relied on them for cooking their meals. This black ironware has been extensively used and highly regarded. It is also fairly inexpensive. At the heart of this cookware is the “Dutch Oven”. This is outdoor camp cookware. For those that have ready access to firewood, this type of cookware can be ideal for surviving a major disaster. This type of cookware requires seasoning prior to its first use, so carefully read the instructions before its initial use. This seasoning is normally done by rinsing in hot water (not using soap) and then immediately drying and then applying a thin coat of vegetable oil (for example, Crisco) or a cooking oil spray (for example, Pam) to the pot (inside and out) and then placing it on a fire for at least an hour. After the pot is removed, let it cool off naturally. Then clean the pot with a stiff brush and hot water and immediately dry thoroughly. Then reapply a thin coat of oil to the pot while it is still warm. This is called the seasoning process. There are some simple rules with cast iron cookware. First, never place them in a dishwasher. Otherwise they will rust. Second, never use soap or detergent on them. And third, never pour a cold liquid into them while they are still very hot. Thermal shock can cause metal to warp or crack. Other than those guidelines, this cookware is very rugged and will last centuries if properly cared for. If water is difficult to obtain, this cast iron cookware can be cleaned simply by placing the pot back on the fire and burning off the residual food. After it has been carbonized, the ashes can be simply brushed away.



Figure 15. Cast Iron Cookware



Figure 16. 8-inch Victoria Cast Iron Tortilla Press

4. *Tortilla Press* – A tortilla press is very handy in making tortillas that look like

tortillas. <http://www.gourmetsleuth.com/tortillapress.htm>

5. Matches – Matches are extremely useful in this type of crisis. The invention of fire brought man out of the Stone Age. Around 35 years ago, I was very much into trail hiking and overnight outdoor camping (me, my sleeping bag and the stars above). At the time, I converted a few empty 35 mm photographic film containers into waterproof storage containers for my matches. Back in those days, these containers were made of metal and had twist on lids. I recently came across one of my old containers with matches still intact. I tried to light several matches but to no avail. They did not stand up to the moisture in the air and the test of time. Currently we consume four or five boxes of matches every year. It is a necessity when you heat your house with wood. As an emergency backup, I disassembled and vacuum packed several boxes of matches. I find it is reasonable to expect a 30-year storage life for matches if they are properly packaged.

D. Lighting

Access to lighting is important during a long duration blackout. I recommend several NightStar Flashlights and a kerosene lantern.

1. NightStar Flashlight – The NightStar model I recommend is equipped with a high brightness LED bulb called the StarCore LED. Shaking the flashlight for 30 seconds provides a full 20 minutes of useable light.

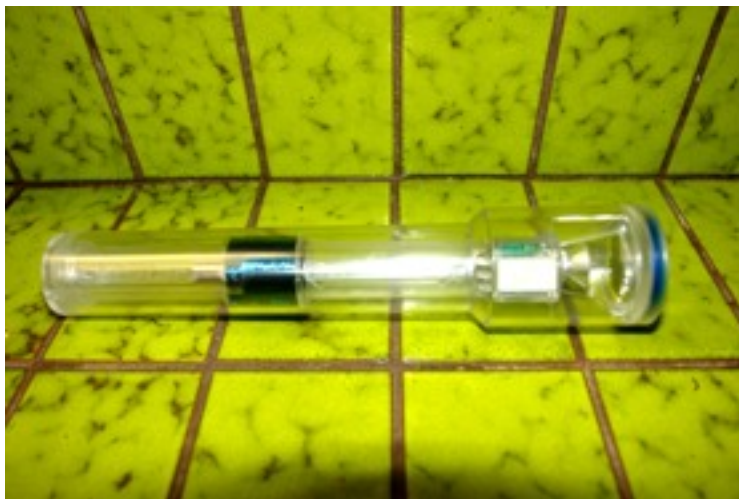


Figure 18. NightStar Flashlight

comparison test with their original model. You can find further information about this amazing flashlight at: <http://www.appliedinnotech.com/nightstar.php>



Figure 17. Vacuum Packed Matches

The flashlight contains no batteries using a capacitor in its place. This flashlight should survive a year of extended use. In a long duration blackout, this type of item is worth its weight in gold. There are several mock versions of this flashlight appearing on the market today. But these flashlights are not all equal. I recommend this particular make and model because of its brightness and run time. When you use a flashlight, you want to use it and not be distracted by having to continuously shake it every few minutes. I gave it the 20 minute run time test and it passed. These types of LED flashlights do not put out nearly as much light as a normal flashlight, so the intensity of the light is very important. This model is substantially brighter in a side-by-side

2. Kerosene Lantern – This Petromax lantern runs off of kerosene. It provides 8-12 hours burn time per tank of fuel (1 quart of kerosene). It produces 400 watts of light. Consumers Report rated these lanterns as the safest in the world. Be sure to purchase extra mantles for the lantern. I also recommend permanently storing ten gallons of kerosene.

E. Sanitation

The loss of electrical power may impact city waste treatment plant. If the plant fails, an alternative may be required. Believe me, this can really become important if raw sewage begins to back up into your basement or starts to overflow from waste treatment plants into rivers, streams, and lakes or begins washing up on beaches or shorelines.

I recommend combining 3 elements to meet sanitation needs. (1) There are portable toilet kits on the market today that use a 5 or 6 gallon plastic bucket with a snap on toilet seat. I would recommend obtaining one of these. An individual could fabricate one by pulling the toilet seat off their toilet and using a few pieces of scrap lumber. But these are so inexpensive, why go through the trouble. (2) In the 1850s, a recycling "earth toilet" was as American as apple pie. It consisted of a seat placed over a container filled with dry earth. After each use, more dry earth was piled into the container. Instead of throwing away the waste in the container, farmers put it to use in agricultural fields as compost. I would recommend that during this



Figure 19. Petromax BriteLyt Lantern, Model 500CP



Figure 20. Portable Toilet Kit



Figure 21. Rid-X Septic System Treatment

type of disaster, individuals use this approach in combination with the portable toilet kits. Fill up a second 5-gallon bucket with fine earth for this purpose. Once the human waste is composted, it can be safely deposited in your yard as fertilizer. (3) I would also recommend purchasing a box of septic tank bacterial agent/enzyme such as “Rid-X Septic System Treatment”. This can be found in many local grocery stores. Add a spoonful of this product to the bottom of the bucket before you begin to use it. This will accelerate the decomposition action. I would recommend keeping the toilet outdoors or in a garage because methane will be released during this composting process. If toilet paper runs out, one can substitute old newspapers in a pinch. Newspaper is biodegradable.

Other designs for effective sanitation systems are outlined at Lifewater International, “Sanitation: Simple Excreta and Washwater Disposal” <http://www.lifewater.org/resources/sanitation.html#SAN> .⁹

F. Cold Weather (Heating & Clothing)

I have personally experienced both physical body extremes: severe hypothermia and severe heat stroke. In hypothermia, the human body begins to shake uncontrollably. It’s as if the furnace deep inside you goes out. And you become very aware that you are dead unless you can get it restarted again. You might crawl into a sleeping bag but your body can’t stop the shivering because your body is no longer generating sufficient heat to warm the sleeping bag. In the dead of winter, without electricity and heat, take immediate steps to keep you and your family warm. Bundle up in extra layers of clothing. At night use sufficient blankets and sleeping bags to keep the heat within. In a hypothermia state, two bodies can be better than one to rekindle the internal flames. And I say that quite literally.

In cold weather regions, I recommend purchasing sleeping bag rated for the coldest weather your area might potential experience, self inflating sleeping pads and a few down blankets. Sleeping bags are rated for their respective temperature ranges and some are usable down to -30° F. I strongly recommend buying thermal underwear (both tops and bottoms) for all members of your family.

Men during cold winter months should allow their facial hair to grow. It will provide them addition warmth and protection. After all we come from a heritage of mountain men.

In Indiana during the early months of 1978, a winter blizzard descended upon Tom Bishop during the night. The temperatures dropped to -25° F. Sometime after midnight, the power went out. He heated his house with fuel oil. Without electricity, the furnace shut down. When the electricity was restored an hour later, the fuel oil had coagulated into a substance that resembled Jell-O. He was unable to restart the furnace. He woke his wife and children and loaded them into the car and made his way in the storm to his mother’s house. But the car’s tires were bad, and he blew two along the way. What normally would suffice as an inconvenience, a one-hour loss in electricity, in extreme cold can easily turn into a life and death struggle. Later that year, he purchased a wood stove as his backup heat source.

I have heated my house solely with firewood for the past 30 years. At the time I purchased my first stove; Jøtul produced one of the only high efficiency (> 70%) wood stoves on the market. This is no longer the case today. There is a fine selection of high efficiency wood stoves produced today. Why is high efficiency important? If I decide to buy my firewood instead of cutting & splitting it, my cost is \$200 per winter.

Because of the size of my house (~300 linear feet of exterior walls), it could easily cost me ten times that amount using a more conventional fuel source. When selecting a wood stove, consider ease of loading firewood, ease of removing ashes and most importantly the efficiency rating.

In areas with abundant firewood, wood stoves can be an effective backup heat source. For many individuals, a space



Figure 22. Jøtul Firelight Model #12 Wood Stove

heater (kerosene heater designed for operations inside a house) will meet this emergency need. A fireplace is very inefficient at heating a home during a winter. Fireplace inserts generally incorporate electrical blower motors. These inserts can provide some heat but will not be very efficiently without electricity. Never use a gas oven, gas stove, or unvented appliance to heat your home due to the potential of carbon monoxide poisoning.

In a crisis, you do not need to heat the entire home. Reduce the size footprint of your home by closing off areas (shutting doors) and placing towels at the bottom of the door to seal out drafts. This will minimize your overall heating requirements.

G. Electricity

1. Emergency Electrical Generator – If you live in a house, a portable emergency electrical generator may be an important tool during an extended power blackout. Before you make that decision, analyze your basic needs. In my case, for example, I have a well and with a portable generator, I could supply my family with clean drinking water during the entire crisis. I would only need to power the water pump for about 10 minutes two or three times per day. This analysis will determine the type of electrical power (voltage/current) that is needed. I reviewed the manual that came with the water pump. I need 4.8 amps maximum at 220 volts to power the water pump. The generator I chose provides 220V at 30 amps. So I have ample electrical power for this intermittent task.

After buying the portable generator, there are several tasks that should be done prior to any emergency. First determine where you will place the generator during operation. These generators should never be used in the house, basement or garage because they generate deadly carbon monoxide fumes. They should be placed outdoors in close proximity to the major appliances/equipments, that need to be powered. These units are noisy and can become unsettling to your nerves if they are used continuously. Once the location is determined, the first step is to install a grounding rod and create a grounding cable. Generally, it is recommended that you power devices directly from the portable power generator. The second step is to fabricate any unique special cable required. Generally this will take the form of a 220 volt extension cord. When you deal with 220 volts, there are a variety of connector types. As a result since you need to match to your specific



Figure 24. Portable Electrical Generator, BlackMax, Model PM0496500, 13 HP, 6500 running watts, 8125 max watts

equipment, you may be forced to make one because you will never find it in a store. Measure off the distance from the generator to the critical elements that you will power in an emergency. In my case, this is the water pump. Then fashion an extension cord. The size of the wiring should match the expected



Figure 23. Dyna-Glo 23,000 BTU Portable Kerosene Heater, Model RMC-95C

load. If you lack the knowledge or expertise, you will need to hire an electrician to fabricate one. Refer to Figure 25.

The third step is to purchase a general purpose long (100 foot or greater) heavy duty 120 volt extension cord. This is to allow the flexibility to power any item in your house even at its farthest reaches. I recommend a grounded 12-gauge extension cord for minimum voltage line drop. These will be hard to find and expensive. But they are available for purchase. It is possible to string a number of shorter and thinner gauge extension cords together but thin cords will not carry the load and each connection you add will rob you of valuable electrical power. If you have electrician knowledge and expertise, you might even make some up. I put together 2 extension cords each 250 feet



Figure 25. Extension Cord for 220 Volt Water Pump

long using normal 12/2 household wiring. This allows me to put power wherever it is needed with minimal line loss. Refer to Figure 26. All these tasks should be done prior to the crisis because chasing around town during a disaster trying to find critical parts or expertise is a disaster, and definitely not good disaster preparedness. The final step is to purchase a dozen 5-gallon plastic fuel cans. You should have some indication that a massive solar storm is about to hit. When you get the warning, immediately fill up

the fuel cans with either gasoline or diesel fuel required to power your portable generator.



Figure 26. Two Extension Cords 120 Volt, 250 Feet Each

Do not connect a generator to a home's electrical system without first disengaging the house from electrical utility (generally this is done using a code-complying transfer switch between the home main circuit breaker box and the utility pole with the transformer that supplies the house). In newer communities this may be difficult because the equipment may be underground and feed several houses. Otherwise, you may be responsible for electrocuting the utility lineman who is

trying to reconnect your electrical service.

When hurricane warnings were issued along the coast, many individuals rushed to their local stores and purchased portable electrical generators. When the crisis was over, many of these same individuals returned the items back to the stores requesting a refund. In some cases, the individuals purposely damaged the generators so they could claim the item was defective. This approach is downright unethical. I would recommend that merchants, in advance of a major geomagnetic storm, place signs in their windows that indicate emergency electrical generators are non-returnable and also stamp receipts of these items as non-returnable. On the other hand, I would expect merchants to demonstrate that the units are in working order before they leave the showroom floor.

2. Vehicle Electrical Generator – Some commercial vehicles utilize the engines to produce backup electrical power. Remote power generators are not new and are generally used in vehicles where remote power is necessary. Most often, these units are mounted in the front of the engine compartment with a

belt pulley aligned with the vehicle's crank pulley. Other common uses are for ambulances, fire and rescue vehicles, police cars, utility service vehicles, and industrial and military vehicles. This is a deployable potential asset that could find significant non-traditional use in restoring functionality to some of the infrastructure during a long-term blackout.

3. Alternate Energy – As an experiment in 2001, I installed a solar panel system to provide electrical power to my pole barn. I found the system to be very expensive (around \$ 3,500) to purchase and complex to put together. The system is reliable but requires yearly maintenance. The system consists of two Kyocera KC-120 Solar panels rated at 120 watts each, a Trace Engineering DR3624 Power Converter/Charger, a Trace Engineering TC60 Charge Controller, a Trace DC Disconnect/Overcurrent Module and an assortment of other devices. In general, I found the manuals for each equipment element to be fairly detailed but there were no instructions on how to assemble the components together. And the company that sold me the equipment was less than helpful in responding to my questions. It was almost as if the sales company was also in the installation business and frowned on anyone else assembling their systems. And these systems are complex. After some effort, I place the unit in operation and it has worked fine for over 6 years. After several years, the deep discharge lead-acid batteries went dead. These are expensive batteries. I had not maintained the batteries, so it was my fault. I removed the vent caps and the batteries were almost bone dry. I filled them with distilled water. It took almost two gallons. After a short while, the batteries healed and are now fairly recovered. Unless you live in a climate that gets year round sunlight, I would probably not recommend purchasing a solar panel system as an emergency electrical power backup until the prices drop significantly. But if you do purchase one of these systems, then I would recommend that you also consider purchasing low wattage appliances. There are several very high efficiency refrigerators, freezers and other appliances available on today's market, if you know where to look.



Figure 27. Kyocera Solar Panels

<http://www.survivalunlimited.com/refrigerator.htm>

How might an alternate energy system be useful during a long duration blackout? Whereas electrical backup generators are very useful for temporary heavy short-duration loads such as water pumps, alternate energy systems could power low-to-medium current, long duration loads. If a major blackout happens, the electricity from the solar panel system might be used to power my freezer in the garage. This might give me the means to use up the frozen food in an orderly controlled manner. I might be able to use solar power to run the freezer during the daytime hours only and rely on the freezer insulation to keep food frozen



Figure 28. Trace Power Converter/Charger

during the night. (I might be able to further minimize the night-time freezer cooling loss by wrapping the freezer with a layer of fiberglass insulation when the freezer is not powered.) The freezer is a newer design in which the compressor motor runs almost continuously but the amperage draw is lower than older models. The freezer rated watt hours per day is very close to the maximum wattage I can expect from the solar array. As a result an operational test was called for.

On 26 September 2007, I ran an operational test. It was one of those foggy, cloudy, rainy days with a little thunder in the distance. This was a less-than-ideal weather day, but a very good day to operationally test the concept. The solar system worked well through the first two freezer compressor cycles. But then the freezer stopped. Oops, I broke the new freezer! Wife will be mad! I plugged the freezer back in the normal A/C wall outlet and after several minutes it began to work again. Whew! The problem was not because the freezer drew an excessive load, but quite the opposite. When the freezer's compressors are not running, the freezer is pulling a very minimal load, only enough to drive the temperature sensing and control circuitry. The inverter has problems with very light loads. If the power consumed by a device is less than the threshold cutoff of the inverter circuitry, it will not run. The Trace Power Converter/Charger has an adjustable dial called "search mode watt control". When this dial is turned completely counter-clockwise, the search mode feature is defeated. This corrects the problem I experienced.

All in all, I consider this a good test. The solar system appears to handle the freezer load even under adverse weather conditions provided the search mode feature on the inverter was disabled. The line loss from a 200-foot run between the solar panel system in the pole barn and the freezer in the garage was managed well by using a single 12-gauge extension cord.

H. Medical Emergencies

Injury and disease may arise during a prolonged disaster. Medical expertise, facilities and supplies may be unavailable. Expert text dealing with medical/dental problems in a low tech environment exist and could be extremely beneficial in this type of crisis. "Where There is No Doctor" is an excellent comprehensive emergency medical guide.¹⁰ Included in this book is a description of material needed for a comprehensive home medicine kit (pp. 334-335). The list includes both prescription and nonprescription medicine and medical supplies. I showed it to my physician and I asked him about shelf life. He said that the drugs on the list were not the types that become dangerous when they exceed shelf life, they only lose potency. I asked him if a hypothetical disaster was about to happen, would he give me a prescription to this medicine. He said it depends. If it was someone that walked in off the streets, the answer would be "no". But if it was someone he has cared for over several years and the reason was to prepare for an impending disaster, he would probably write the prescriptions. He said that the medical insurance companies and HMOs would frown on covering the expense of the medicine. The prescription medicine would cost between \$100 and \$200. "Where There is No Dentist" is a fairly comprehensive emergency dental guide.¹¹ I recommend purchasing both these books. Hopefully, you will never need to use them. But by having them, you are prepared for most medical emergencies, even extreme ones.

I also recommend putting together a comprehensive home medicine kit by purchasing the nonprescription components listed in the book. Then immediately prior to a crisis, visit your doctor and obtain prescriptions for the rest. (After visiting the local drug store, I discovered several items listed in the medicine kit were a little



Figure 29. Bronson Laboratories Vitamin C

difficult to obtain. Substitute nonprescription drugs RID Lice Killing shampoo, Tinactin, and Lamisil for sulfur. Tylenol is a common form of Acetaminophen. Substitute nonprescription drugs Neosporin or Polysporin for Gentian violet. The book cites prescription drugs oxytetracycline or chlortetracycline eye ointments as the recommended antibiotic eye ointments.)

When an individual has scurvy, their cuts and bruises do not heal properly, their gums become inflamed and their teeth begin to fall out. Eventually individuals die from the disease. During a prolonged crisis, individual may have to survive on basic food stock (corn, beans & rice) and live on a diet with little fresh vegetables or fruit for several months. After several months they may end up with scurvy. I recommend individuals store a supply of Vitamin “C” in crystalline form. In this form, vitamin “C” will store indefinitely without any loss in potency. Figure 29 shows a 1 kilogram (2.2 pound) bottle of Vitamin C sufficient to provide 42 individuals with a year’s supply of the minimum daily dose of 60 mg. http://www.bronsonvitamins.com/app/search/detail.htm?&item_id=49

I also recommend including a bottle of Tea Tree Oil in the medicine kit. This item can be found in many health food stores. Australian aboriginals used tea tree leaves for healing skin cuts, burns, and infections by crushing the leaves and applying them to the affected area. Tea tree oil contains constituents called terpenoids, which have been found to have antiseptic and antifungal properties. I personally found this item to be very beneficial for skin infections.

I also recommend including bottles of nonprescription drug Tecau & Calagel (these are sold together) for poison ivy and poison oak in the medicine kit. Calagel is also very useful against insect stings and bites.

I. Security

Fifty years of social science research on disasters has shown that panic is rare even when people feel excessive fear. Human nature tends to shine brightest in adversity. People are naturally social. In a disaster, even a global catastrophe, individuals will help those nearby, even complete strangers, before saving themselves.¹²

But I am not naive. There are always those that will look at a disaster as a golden opportunity to cause mischief. Therefore, I feel it is important for an individual to be prepared to defend themselves and their families. Band together with your neighbors to form small neighborhood watches, to watch over each other and protect yourself and your neighbors, to help each other out during a time of crisis.

There are many farmers living quiet lives out in the country. Generally, they do not worry about burglars breaking into their homes late at night. The reason is that most farmers possess two special items. The first is a large German shepherd. The dog stands vigil during the night and watches over the family while they sleep. Thus the term “watchdog” was created. The second item is a shotgun. The shotgun is there at the ready if needed should danger arise, whether it be wild animals or one of the human variety. With a shotgun, you don’t need to be an expert marksman to be effective at close range, the spread pattern from the pellets is very effective. For the most part, nobody messes with farmers.

You don’t want to be alone in the dark with a pack of hungry wolves, howling at your door. The second amendment of the United States Constitution gives the American people the right to keep and bear arms. This type of disaster is one of the reasons why this right was included. Some States and cities have usurped this right. That is unfortunate. So unless you live in one of those areas that restrict your rights, I



Figure 30. Tea Tree Oil

would recommend you purchase a shotgun for your protection. I recommend that you lock it away for a time such as this.

J. Other Considerations

1. HAM Operators – Technology has increased the flexibility of communications. Current communication relies on an infrastructure grid that will be strongly affected during a massive solar storm. This transition has even invaded the ham radio field where repeaters are heavily relied upon. Therefore my recommendation is to return to basics, a ham radio license and HF mobile transceiver. The unit can be powered by a car battery and the communications can reach around the world without a repeater.

2. Bicycles – In cities, bicycles become very useful in a long sustained electrical blackout.

3. Landline Telephones – For those who are too young to remember or know, in the old days, telephones were at least as large as size 8 shoes, and they were tethered to telephone wall jacks by telephone cables. The vast majority of those phones got their power (Direct Current) through that telephone cable, and the telephone company had its own backup power. I recommend that individuals keep one old-fashioned emergency telephone on hand (no frills, without a cordless phone docking station or an answering machine that requires its own AC power) in preparation for the next blackout.

4. Extra Fuel Cans – I recommend that individuals purchase a dozen 5-gallon plastic gas cans. Store them empty. In the prelude to a massive solar storm, run down to a service station and fill them along with your vehicles. It is a lot easier to fill these gas cans then it is to locate and purchase spare gas cans when everybody under-the-sun is trying to hunt them down. If the fury from the solar storm doesn't materialize, you can simply use the gasoline to fuel your vehicles for the next few weeks. But if the solar storm reaches the magnitude similar to the 1859 storm and takes down the electrical power grid for an extended period of time, then having 60 gallons of gasoline on hand gives you several important options. It gives you sufficient fuel to operate your portable electrical generator (should you own one) intermittently for several months or it allows you the option of driving your family to a very distant city, one with electricity.

For those individuals that need the security of storing gasoline over months and years, look up the product called "STABIL". It is an additive found in auto parts stores that stabilizes gasoline and keeps it fresh over the winter.



Figure 31. SciTec AEGIS 2510D Desk Phone



Figure 32. Five Gallon Heavy Duty Buckets

5. *Extra Heavy Duty Buckets* – It is a good idea to have several 5-gallon heavy duty buckets on hand. They have a variety of emergency uses, for example hauling water up from a creek bed. I obtained several used ones for free from “White Castle” restaurant. They were leftover pickle barrels. The only drawback was they had a pickle smell that wore off over time. After a few visits, they began to charge me a dollar each for the buckets, but that is still a lot cheaper than the price of new ones in the stores.

V. Proactive Approach – Organizational

A. Organizational

There are several steps that organizations and governments can implement to address or minimize this threat.

1. *Service Stations* – I encourage every gasoline station to have an emergency electrical generator and to have modifications made to their main electrical connections to permit easy integration. If your service station is the only station able to pump fuel during a major blackout, expect tremendous sales.

2. *Traffic Lights* – Some cities have recently upgraded many traffic signals from incandescent lamps to light-emitting diode (LED) displays, which require significantly less power to operate. I recommend that these cities add battery backup to the LED signals at critical intersections to keep them operational during a blackout.

3. *Emergency Communications* – The U.S. Defense Department is exploring the use of high-altitude balloons operating near the edge of space (65,000-102,000 feet) to set up emergency communications networks on short notice. I recommend the government follow through on the development of these systems because they could provide a rapid reconstitution of communications for emergency responders. This type of platform should be deployed after the threat from the geomagnetic storm has subsided to prevent damage to the platform’s electronics.

4. *Old Standard* – Most agencies after experiencing a major blackout thought they had more communications redundancy than they did; failed to understand the frailty of their technology; and thought that they had better backup power. During a blackout, many officials learn the importance of low-tech solutions. The plain old telephone system proved to be the most reliable form of communications technology during a blackout, because cell phones, cell phone towers, radio repeaters, and Internet connections failed due to the loss of electrical power and limited backup capabilities. During past blackouts agencies discovered the importance of facsimile machines, pagers, toll-free numbers, conference call lines, older radio systems, and previously installed dedicated landlines. I recommend maintaining some older technology, which may be less susceptible to power outages, in disaster management and control centers. As for backup power, even quadruple redundancy is not foolproof.

5. *Emergency Systems Design* – Several systems used by infrastructure agencies are generally left off the list when it comes to emergency power backup. These elements should not be overlooked. Backup generators and uninterrupted power supplies are worth the money, in this type of emergency.

- Electronic keyed door entry systems
- Network-based telephone systems
- Fueling systems for public and private vehicles
- Sump pumps for tunnels or roadway sections that are prone to flooding
- Spare outlets within emergency response centers for small appliances (such as battery rechargers)
- Air-conditioning for IT equipment rooms
- Internet servers hosting e-mail systems
- Radio communications systems
- Building security systems

6. *Satellite Hardening* – Most commercial satellites rely on readily available cheap, off-the-shelf electronics. Radiation hardening is a process of redesigning microcircuits so that they are more resistant to high-energy nuclear particles. Currently I believe we are cutting far too many corners in commercial satellite design. This will jeopardize reliability. I recommend that the U.S. impose hardening standards on commercial satellite system design to increase their robustness against the solar storm threat.

7. *Spacecraft Shielding* – Not all radiation is alike. High-energy nuclear radiation (from protons, neutrons and ions) can be one of its deadliest forms. When an individual is exposed to high-energy nuclear radiation, at the Bragg peak depth, a large amount of high-energy electrons are produced that cause multiple ionization events at the end of their range in a distance that corresponds to the cross section of a deoxyribonucleic acid (DNA) molecule. This ionization produces cluster damage at the DNA level. Energetic protons, neutrons and ions have a greater biological efficiency than X-rays and Gamma Rays to induce genetic damage. X-rays can produce isolated single and double DNA strand breaks, which can be repaired by the cells rather quickly and cleanly. High-energy proton and ion radiation produces complex cluster damage to the DNA strands that are significantly less repairable. Individuals with the greatest exposure to this type of radiation are astronauts outside the protective envelope of Earth's magnetic field and outermost atmosphere. During off-world missions to the moon, to Mars or deep space travel, solar storms will expose astronauts to this great threat. A massive solar storm can literally become a killer storm.

As a result, I recommend utilizing salt water as an effective shield against this threat. Figure 33 defines how protons, heavy ions (such as carbon ions) and photons (such as X-Rays) interact as they travel through a column of water. The heavy charged particles (protons & ions) are able to cut easily through objects and dissipate significant energy at a penetrated depth (referred to as Bragg peak). When the particles are slowed down at their penetrated depth (for 148 MeV protons, the Bragg peak is at approximately 140 mm [5.5 inches]), the interaction time becomes larger and the value of the energy transfer is at its maximum. Fast nuclear particles (protons & neutrons) must be slowed down before they are captured. Light nuclei, such as hydrogen, are effective at slowing down these particles through elastic scattering. That is the reason why water (which contains hydrogen) makes an effective shield. Other atoms (boron, cadmium, chlorine, iron, fluorine, lithium and potassium) are very efficient at absorbing nuclear particles once they have been slowed. As a result adding salt (which contains chlorine atoms) to the water dramatic improves its efficiency in shielding design.

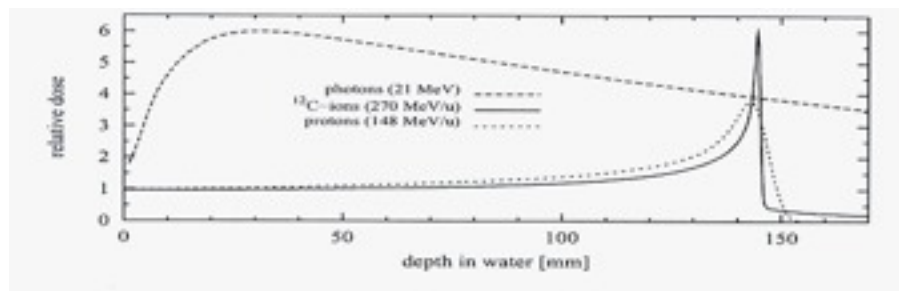


Figure 33. Proton, ion and photon radiation penetration through water.¹³

I recommend that robust water shielding be incorporated to any spacecraft designed for deep space missions. Water is a natural shield for high-energy nuclear particles comprising the solar proton event particles within a major solar storm. A shield of salt water, two feet thick will filter out most of the high-energy particles below 0.5 GeV. The designed shield area should protect the sleeping compartment within the spacecraft. Those compartments should also house the main computers and sensitive electronics so as to provide protection to those critical components. The shield need not completely enclose the compartment but only one side of the compartment. That side should always be oriented towards the sun during space flight. The highest energy particles will travel a near straight line path from the sun. The shield may look like a flat disk approximately two feet thick, a type of water storage tank. The water

contained within this tank will also serve as a drinking water supply for the crew of the spacecraft. This storage tank should be integrated with waste water capture, water recycling, and water desalination and treatment systems.

8. Grid Design – I feel it is important to require electrical utilities to invest in geomagnetic induced current (GIC) mitigation.

Three types of power autotransformers were field tested by Minnesota Power to evaluate their response to DC excitation: single-phase shell form, three-phase three legged core form, and three-phase shell form. All transformers exhibited half-cycle saturation due to DC excitation, but single-phase transformers were more susceptible by almost a magnitude of order.¹⁴

Oak Ridge National Laboratory tested three types of distribution transformers:

- Two three-phase 75 kVa wye-wye connected 12.47 KV / 208 V / 120 V units.
- One three-phase 300 kVa 12.47 kV / 480 V wye-wye connected unit.
- One 75 kVa three-phase 12.47 kV / 208 V / 120 V delta-wye connected unit.

The test confirmed that ungrounded-wye connected transformers and delta connected transformers do not provide a path to earth for GIC. Grounded-wye connected transformers begin to show saturation effects at GIC levels from 2% to 50% of the rated AC current. Distribution transformers can be driven into saturation in about 1 second or less.¹⁴

A blocking capacitor in the neutral of a wye-connected power transformer has been determined to be the most effective point at which to place devices for limiting the flow of GICs into and out of the power system. Series capacitors on each phase of the transmission line, which are needed for VAR compensation on transmission lines, are another effective means of blocking GICs. Utilizing three-phase, three leg core transformer design is another means for minimizing GIC effects.

9. Backup Grid Assets – I recommend the federal government purchase several critical elements of the electrical power grid (e.g. large transformers) as spares and hold these in strategic reserves in order to quickly respond to a massive blackout caused by power grid degradation and failures. These transformers are the size of a house and cost several million dollars each.

10. Decision Authority – Just as one individual in the FAA made the critical decision during 9/11 to ground all airline flights in the United States, there needs to be one individual in the Federal Government with delegated authority who can make the decision to unilaterally place the U.S. electrical infrastructure into Safe mode prior to a rare extreme geomagnetic storm. Electric power companies cannot absorb the risk and lawsuits in manually shutting down the power grid. They will keep the electricity flowing even if it means risking damage and loss of critical infrastructure equipment elements. Only the Federal Government can make that call. The individual in which the delegated authority is given, must not be risk adverse but capable of quickly making an accurate judgment call on the severity of the approaching solar storm.

The general public should receive advance notice of an approaching massive solar storm, the approximate time it will strike and the possibility that a portion of the electrical grid will be placed in safe mode producing general blackouts. This is another function of the delegated authority, to alert the general public.

11. Power Restoration Priority – A priority list should be developed for critical infrastructure which requires immediate electrical power restoration. This power should be supplied by emergency generators and should be the first elements to be restored as partial power is restored. The short list should look like:

- land-line telephone network
- city water pumping and treatment facilities
- waste treatment facilities
- railroad and subway facilities
- fuel storage and refueling facilities
- refineries
- nuclear power plants
- grain processing centers

- hospitals
- emergency responders
- emergency radio stations

12. Bank Holiday – A long-term blackout lasting several months will cause chaos with individual loan payments. Access to funding can be severely restricted during a major crisis. In many cases, individuals will be without a job during the entire extent of the crisis. Individuals will lose their homes to foreclosure or have their cars repossessed because through no fault of their own, they missed payments. I recommend a time-out for blackout affected regions during this period; a suspension of loans until the electricity is restored. There should be no extra interest or financial charges accrued during that time period and payments will pick up where they left off, extending the payment period by the length of the blackout.

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