APPENDIX F
How to Avoid or Cope with Electromagnetic Sensitivity

By R. Bruce McCreary

Most people with serious disabling Multiple Chemical Sensitivity already have some degree of Electrical Sensitivity (ES). Some are unaware of it and blame chemical exposures for symptoms from computers or driving in certain areas, or just not feeling well in some buildings even though there seems to be no smell. Many feel so ill all the time that they just can't tell what the problem is. Some denial is necessary for living well with MCS, too; it allows us to ignore uncontrollable threats from our neighbors, new cell towers, new businesses in the area that could threaten our health and home. Some level of denial is helpful for coping with any seriously disabling condition.

I was in denial about my own ES problems for years, even though I was an electrical engineer (Project and functional manager of R&D). I stayed in denial even though I knew that I was miserable near fluorescent lights, and was unable to use a computer even when it was in a vacuum box enclosure I'd built that completely eliminated all fumes.

In 1989 after becoming MCS disabled from a sick building, I built a custom home with an interior of well tolerated and well-tested unpainted Portland cement plaster. Nonetheless, after moving in I had a serious health crash. I consulted with the top names in Environmental Medicine. Not one suggested that I check the home for elevated magnetic fields.

Later I found out that my home had a wiring error, the most simple and common type of error. Two different circuits' neutral (white) wires were connected together at a ceiling light electrical box and caused magnetic field levels around 6-8 milligauss in the living room when lights were on in that room. So the first winter when lights were on more I went downhill badly, and developed viral encephalitis, epilepsy, and multple sclerosis. The next winter brought similar declines. I still didn't know anything about magnetic fields and without a clue concerning the cause of my problems, developed more and more brain lesions (holes). I had been struggling with constant complex partial seizures, triggered by vertigo. Even simple walking or bending tasks around the house had become extremely difficult. I was in extreme pain, and there were no medical options left.

MCS/ES disability activist Susan Molloy came to visit the following fall and stuck a meter in my face out in my shop. At the height of my head it showed 30 milligauss, from a low hanging fluorescent light. Even knowing that I'd never been able to "test" for provocation/neutralization allergy shots under fluorescent lights, I'd installed them in my shop. "No wonder you're sick, you dummy!" she said.

Still clinging to my denial that magnetic fields could be a problem, the next day I went out to my shop and didn't turn on the fluorescent lights. I had previously only been able to work with my hands only with great difficulty for 30 minutes a day then would have to go back to bed in pain. With the fluorescents off, I forgot the time and when I looked up 3 hours later, I felt as good or better than when I'd started. This set me on a path of EMF reduction throughout my home.

This soon stopped my decline and I was relatively stable for a change. My severe headaches slowly lessened. The more I lowered my home EMFs, slowly but surely, the better I became. If she had not shown me the meter it would have been only a couple years until I would have been in a nursing home or worse. So let me say it clearly and without exaggeration: Susie saved my life by showing me a meter and puncturing my denial. With this chapter on ES I hope to do the same for some others.

Since that time (and after some frustrating failures in some early attempts at computer access) I've made a more thorough study of the Electrical Engineering field of Electro Magnetic Compatibility (EMC), and successfully applied the physics of it on behalf of folks with ES, even though in EMC the target for mitigation of electromagnetic interference is delicate electronic equipment, not humans. I've developed highly sensitive instruments that allow measurement of, and make visible, the waveform of magnetic fields from "ground currents" or "stray voltage," both of which are really neutral currents in the earth, a consequence of the common Wye power distribution system.

Now there's an affordable meter that will let you do the same thing, and now it's what I use most of the time because it's compact and does the job well.

Without being an electrical engineer, you can protect yourself and preserve what health you have left by getting a few simple affordable measurement tools and beginning to use them. What we'll be measuring are power-line frequency magnetic fields and radio waves, including microwaves. You absolutely MUST STOP using yourself as a "meter". This may work to some degree for smells, but it does not work for EMFs. There is too much variability and latency (delay in reaction), and too often the symptoms are indistinguishable from chemical exposures.

It's very common to confuse symptoms from hyperacusis (sounds) with ES, since fans and other sound sources are electrical. A simple meter reading can sometimes rule in or out ES as a cause of your symptoms. If certain sounds are triggering symptoms, experiment with various models of ear protectors until you find some that help. Keeping an open mind about what the source of the problem is (sound, EMF, chemical, other) can help you improve your quality of life and your environmental investigative skills.

Even with very limited knowledge, you can probably reduce your daily magnetic field exposure significantly just by changing where you spend time, relocating some items in your home, unplugging some things and re-wiring mis-wired circuits. Later as you learn more, you may be able to correct wiring errors and net neutral current problems (a.k.a. stray ground current) to further reduce your daily exposure. If you don't have ES yet, you can prevent it by reducing and monitoring your daily EMF exposures.

There are consultants who can do some of these things, but I'm sorry to report that many in the field are incompetent regarding EMF mitigation, especially for those with ES. As with MCS, you have to educate yourself and oversee your own changes in your environment. You must have access to and use the meters regularly to learn your own level of tolerance, and then to avoid places that are above that level.

For testing, each person must carry with them a magnetic field meter and a cheap portable AM radio throughout the day for a week so that they can learn where the hot spots are in their environment. Likewise, they'll each carry a broadband radio wave detector for a few days in order to evaluate not only the home but also other areas in the community where they spend time.

If you are living below the poverty level but are in a support group or patient group, perhaps your group might share in the cost of $360 needed for adequate measuring equipment.

Radio and microwave levels are also easily measured, and sources can be located with the "HF Detektor" for $150. Also, these levels can be lowered using shielding materials like aluminum foil and screen, and UV film for windows.

During 12 years of volunteer consulting work, I've seen that the most common situations leading to developing ES are changes in electrical environments that cause magnetic fields of 1 mg and above, or changes in the radio or microwave environment. If these can be remedied quickly enough, the ES might not be permanent. After 6 months, the degree of remission will be reduced,

and you will have much lower thresholds. One MCS disabled man developed ES after putting a new radio near his bed, but recovered almost entirely in two months after getting a meter and cleaning up his living space.

In the early stages of ES, the sensitivity is very selective. Certain frequencies of radio waves or magnetic fields are problematic, but many are not. Thus, certain electrical appliances and electronics are bothersome and others not, since each has its own unique radiated "signature." Over time, there is a spreading of sensitivity. Constant exposure to a certain frequency microwave tower within a mile, for example, will often lead to sensitivity. But with constant exposure, the effect will be seen as an overall decline in health, with increased chemical and electrical sensitivities to other sources.

The Measurement Equipment You Must Have

Acquire three pieces of equipment:
Alphalab's "Trifield" meter with 100x external probe;
An "HF Detektor," and
A portable AM radio, the cheaper the better.

At present there are no other meters sensitive enough for the typical person with ES. Most magnetic field meters are only sensitive to 0.1 milligauss, but almost every ES person is far more sensitive than that.
Do not be fooled by the common public health proclamations that promise no health effects below I or 2 milligauss. You aren't the typical public if you have disabling MCS, and you are seriously at risk for ES.
Some meter vendors make claims as to their meters' accuracy, but specific accuracy is not important for this use. For most people with ES, a 50% (3 dB) difference is not discernible. The issue is the orders of magnitude, to see whether the exposure is to approximately 0.002, 0.02, 0.2 or 2.0 milligauss. In most cases it's a waste of time and money to make costly improvements that only result in a 50% change unless this is just enough to get below your personal threshold. You can also expect magnetic field levels to vary by a factor of 6 (600%) depending on time of day or temperature due to air conditioning or heating loads. For this purpose, perfect accuracy is just not very important, but sensitivity is.

The Trifield meter with 100X external probe is used for low frequency magnetic fields only. The other settings are not sensitive enough to be useful. The Trifield meter loses sensitivity above 20KHz and is useless at 100 KHz, so is not effective for many modern switching power supplies and DC-DC converters. (Note: switching power supplies are AC to DC, and DC to DC converters change one DC voltage to another. Many electronic devices have both, a bulk DC switching supply, say 28VDC, and then DC-DC converters to make 3,5+-12 volts. Individual circuit boards often have their own DC-DC converters. Most switching power supplies generate high magnetic fields in the 50KHz to 500KHz range, and lots of high frequency E-fields too.)

The cheap portable AM radio picks up where the Trifield meter leaves off (20KHz to 1MHz), but must be held very close to the source because it's not very sensitive. Tune the AM radio between stations at the top, middle, and bottom of the AM band, while holding it near a suspect piece of equipment. If it makes stuttering and squealing sounds, that piece of gear is emitting high frequency magnetic, and likely low frequency radio, waves.
The AM radio can be used this way as a "poor person's near-field sniffer" along wires and cables to see if they are radiating. Unlike the magnetic field meter, you do not take readings exactly where your head or body would be. You hold it near suspect equipment, such as any digital electronics, dimmers, or motor speed controllers, then assume that any fields you identify are radiating throughout the house or office.
With the magnetic field meter, it's OK if there's a hot spot in the room, like near a wire in the wall or near switches. That's normal. As long as the readings are OK where you are, then the low-frequency magnetic field is fine.

You should not have ANY digital electronics active, anywhere in the house, that can not be shut down when not in use unless they're on separate, preferably filtered circuits and are relatively "quiet" devices (low emission).

The HF Detektor is a calibrated broadband meter sensitive from 1 Megahertz to 3 Gigahertz. This means that it picks up starting at FM radio bands, all the way past analog cellular (800Mhz), to digital cellular (2 GHz), and most WiFi (2 GHz with some back links at 4 GHz, which are too high for this meter). This is a very wide range, and the meter is sensitive enough that you can use it in very rural areas that are 20 miles or more from the nearest cell tower. It does not allow you to discriminate between sources very well. It is not a $30K spectrum analyzer – still, it provides very useful information. I've found no other broadband RF meter that is sensitive to 100 picowatts or –70 dBM, the level of sensitivity that is needed. The HF Detektor has an annoying LED display that's hard to read in the sun because the case isn't light tight. The sun can light some LEDs, and the Detektor generates EMI and has an easily broken antenna mount. I'll be glad to recommend another product when one is available but as of July 2005, there are none sensitive enough. The booklet that comes with the meter is outstanding.

Doing Your Own Homesite Survey

The first step is to determine the "background" level of magnetic fields around your home, caused by the power lines, and by the neutral current through the earth produced by our country's unfortunate Wye power distribution system.

Make a map of your house and property, and note where power lines and your transformer are located. [The transformer may look like a big cylindrical garbage can up on the power pole, or it may be a large metal box in the front yard.] Now turn off your main circuit breaker so that all your power service is off. This will eliminate magnetic fields caused by your own wiring errors and appliances. You want to find out just how low you can get your house. It can get no better than the ambient level caused by power lines and the ground/neutral current in your area. Some of what you measure is also commonly caused by neutral current flowing on metal water pipes. For ES folks, PVC water pipes are your friend. (More about how to correct this later.)

Walk around the lot with your Trifield meter set on the 0-3 magnetic scale, without the external probe. If you don't get a reading, then cheer and plug in the external probe. With the external probe, measure and add three readings: the probe vertical, the probe across your body, and the probe pointing away. Make sure you steady the probe with your body or on the ground, as shaking the probe in the earth's 500 milligauss DC magnetic field will generate an AC field. When you are not using the external probe, the Trifield meter's three small internal probes add them for you.

For the most accurate figures you would take the square root of the sum of the squares of the three values, but this level of accuracy is not needed. Write down your findings on the map. You should see readings increasing as you head toward the power line. It is typical for there to be a gradual decrease across your lot as you move away from the power line whether it is buried or above ground. If the reading out in your yard is 0.5 milligauss or less, do a Snoopy dance. About 0.2 milligauss is average for the suburbs and small towns, and it can't be corrected without changing the power company's Wye distribution system to Delta. It's sad, because with a Delta system, and avoiding multiple earth grounding, most of the suburbs could be below 0.002 milligauss (which is where I'm now comfortable).

If your ambient level is 2 milligauss or more, you should probably move if you or a family member has MCS or ES. (The average suburban reading according to EPRI statistics is 0.2 milligauss.) Until then, see if you can reduce exposures in the house. In moving, look for homes near the end of a local branch of power service. Only there can you find very low magnetic field levels (0.002mg). The more homes past yours along the Wye distribution system, the more return

current goes through the ground/aquifer instead of through the neutral wire. Heavily loaded, high voltage Wye transmission lines in very rural areas can create a large swath (up to 6 miles wide to 2 microgauss) of land parallel to the line which carry the neutral return current to the power plant. The waveform of the magnetic field created by this neutral/ground current is typically a ragged 60Hz triangle wave, with lots of high frequency content as well as very low frequency level shifts.

In the Wye system for secondary distribution to homes, a low voltage “Neutral” wire is run without ceramic insulators along with a 7200-volt line, which is on ceramic insulators. There may be up to two more 7200-volt lines on insulators. The additional two wires are what are called the second and third phase. This will not change the ground current situation. However, when 4 wires are present you will be subjected to 180 Hertz , which hurts about 3 times as much. (Pun intended, but also true.) Three-phase power is required for motors bigger than 7 horsepower. The Neutral wire is connected to the earth at every junction and every few poles, and is jumped AROUND your transformer by a wire called a “ground tie”. You are NOT isolated by the transformer from the line. This is a big problem if you consider magnetic fields a health risk. Yet power companies are converting their Delta systems to Wye, and many linemen have never even seen a Delta distribution system. Because of the enormous (millions of earth connections via ground rods if a million homes are served) earth connection, Wye systems are perceived as having better power quality; there is less high frequency interference on the delivered power. Unfortunately this high frequency energy is directed through the earth, ruining the magnetic field self canceling of the transmission wires, and generating low level, higher frequency AC magnetic fields throughout our communities and bodies. A Delta system (or Unigrounded Wye) with an isolated (derived at the secondary side of the customer transfomer) low impedence earth ground and properly filtered reactive loads can have good power quality but without generating magnetic fields throughout our communities.

If you see two wires on your distribution poles, but they are each on an identical ceramic insulator, dance a Snoopy dance because you are looking at a Delta distribution line, or a rare system called “Unigrounded Wye” or known as “ungrounded Wye”. On a Delta system, the lines are never grounded and a ground is created on the customer (secondary) side of the transformer. Thus you don’t have large area neutral/ground current problems in areas served by a Delta distribution system. The Unigrounded Wye system grounds the neutral only once at the substation, and has all the benefits of the Delta system, and a low voltage neutral wire. It looks like a Delta line coming to your home. Please contact me so I can let others know about your Delta/Unigrounded wired area. In areas served by Wye distribution, there may be some homes served by two hot phases as in a Delta system (no neutral, both wires on insulators). If the surrounding areas are Wye (one wire not on insulators), you may have only somewhat reduced levels of neutral/ground current. In some areas, an older town may still be Delta but the surrounding areas are Wye. Keep your eyes peeled and your meter at hand.

Doing Your Own In-Home Survey

You should be able to achieve your home site’s ambient level within the whole house, (except for hot spots listed below) even if your ambient level is 0.002 milligauss. The power company(s) would like you to believe that higher levels are unavoidable. This is just not true. Homes in areas with exclusively Delta primary distribution lines can have levels below 0.002 milligauss unless they have wiring errors or grounding screw-ups. Turn on lights in every room and all other commonly used circuits and then take some readings in the living areas of each room. Measure wherever you spend the most time, and especially the bed, and head of the bed. If you see elevated readings in part of a room or a whole room, you have wiring errors that you can locate and fix at the cost of a wire nut (20 cents) and maybe 3 hours of your time. I’ll explain that process in detail in the next section.

Expected spots will include the hot water heater - you need about 12 feet to reach 0.002 mg from a water heater. If your ambient level is 0.2mG, it will be down to that in about 5 feet. If your water heater readings are above 0.2mG at much further distances, you need to replace the wire

between the elements with a twisted pair; pull your new twisted pair of wires through the insulation between the upper element and the lower element close to the case with a coat hanger. If the water heater is too near a living space, add a relay near the power panel to that circuit, and a switch in the living space nearby so it can be turned off. If it is close but not quite good enough, a standard replacement element can be carefully twisted in a vice to reduce magnetic fields by half or more.

Another hot spot is the power panel. You need about 10-12 feet from a moderately loaded power panel (less if your ambient levels are higher). If it's in a bedroom, don't put a chronically ill person in that room. Make that a storage room. If it's a large room, put the bed on the far wall from the panel.

If the panel is a sub panel (no meter), you can often reduce the field levels by half or more by moving the service wires so that they are close together or slightly twisted together. Magnetic fields are a function of current multiplied by the current loop area. Reducing the area between the wires helps dramatically. 5% silicon steel, grain oriented, can be used to reduce magnetic fields from a power panel by about half. The steel must cover a large part of the wall behind the panel and must have the grain oriented in the right direction, which will be the direction that results in the lowest measurement. Conetic alloy brand or other Mu metals are typically too expensive for such a large area. Nor will they provide much more than a 50% reduction. I usually don't bother with 50% reductions that cost a lot of money. That isn't enough of an improvement to bother unless it's very cheap and easy to do so. Remember, the improvement we are thinking of will be by factors of 10, like from 2.0 to 0.2 milligauss. For new construction, put power panels away from living spaces, such as in a utility/storage room. Mounting your power panel on a pedestal 8 feet from the house is also a good choice.

Refrigerators are hot spots and are a surprising source of high EMFs because they use an open frame motor to move air from the freezer to the refrigeration section. You can reduce the fields by fastening 5% silicon steel behind the freezer compartment where the fields are strongest, and another piece against the back wall of the freezer. A motion detector with time delay is also helpful. See "The Well-Behaved Refrigerator" at http://www.ctaz.com/~bhima/emf.htm

The motion detector turns off the refrigerator as you approach, and will turn it back on once you've stopped moving around the kitchen. A proximity detector (typically uses a 100 KHz pulsed IR LED source) would be ideal, but only an IR motion detector is low enough EMF (passive, no pulsing) to be used for the ES disabled. Only a tiny toroidal transformer can be used, as the typical wall transformer generates too much AC magnetic field. Toroidal transformers are donut shaped and are "self canceling'; a small one is below 0.002 microgaus in just a couple feet. They are not commonly used because they cost more than the common "E" frame transformers. Digikey.com has a wide selection of toroidal transformers.

The best refrigerator is one that doesn't have the open frame motor, and does not use a fan over the hot condenser coils. A European made brand called "Conserve" is the lowest noise and EMF on the market today. It has only a compressor motor, no evaporator or condensor fans. This is nicer than the equivalent 1960's US models in that the condensor coils in the back of the unit are not exposed (the rear is hot but smooth) so it doesn't gather dust and loose efficiency. This unit plus a motion detector to allow you to load it without EMF exposure is a good solution.

Many people with MCS/ES also have hyperacusis (sound sensitivity) and even the hum of a compressor is bothersome, so must put the refrigerator in the garage or even in a detached building or porch. An ideal solution would be to remote the compressors and condensers outdoors and have only evaporator coils in the refrigerator and freezer compartments (no fans) so that NO moving or electrical components but the thermostat would be indoors. This would make the indoor refrigerator noiseless and EMF free.

Another hot spot that uses an open frame motor is the bathroom vent fan. Try to replace it with a "shaded pole" motor vent unit or limit its use and know the distances needed to avoid it with your meter.

Dishwashers and other appliances need to be checked and/or modified to be OFF when they are switched to off. The most common problem is the electric stove with electronic display/timer. Adding a switch so that the display is off while you use the burners is a big help. The burners don't use the display/timer. Like most people with severe MCS/ES, I have memory problems. Adding a relay for the electric stove with a mechanical timer has helped me greatly - the stove turns itself off if I've forgotten to check on it. Smoke damage to my home was a regular part of my life before that modification.

Electric ovens shouldn't be used by ES people, as the magnetic field extends almost 24 feet (to 0.002 mg), and the field strength is so strong at the oven that even a brief exposure is often debilitating and sensitizing. A gas oven or grill (which can be used for baking with a double bottomed pan) outdoors is a better solution if the gas can be tolerated outdoors. Otherwise, a remote power switch controlling a relay at the power panel feeding the electric stove is in order. Using it, you can turn off the large oven or countertop style oven from a safe distance before you check on the contents, and can turn the oven back on only when you are at a safe distance.

Adopting a "hit and run" approach to cooking on electric burners is also advised. Do not stand by the burner and stir or watch unless you turn the burner off. I hope to add a pressure mat with switch to my electric range circuit (now it just has the mechanical timer and relay) so that the stove will turn off when I step on the mat.

Electronics that stay on "standby" are another big problem that is easily fixed. Using your AM radio, turn off your TV, cable or satellite receiver, and then check them out. With the radio right on the units, you should hear a pulsing noise and/or some loud static. Put switched power strips on all these units, so they are really off when you're not using them. Satellite dishes are big offenders, because the cable to the dish is active and radiating all the while the unit is "off," so it's a 24/7 exposure until you put in a switched power strip. Satellite dishes are much less radiating if the dish is post mounted on the ground, with a ground rod at the dish and another near the receiver box connected via a grounding block on the cable. The lowest EMF arrangement also uses metal conduit for the coax cable grounded at the dish and near the house. The AM radio is good for checking the cable to the dish to see if it is radiating. Remoting the satellite dish receiver to another building, using an IR extender and the video cable in rigid steel conduit is an ideal solution.

Fixing Wiring Errors in Your Home

According to EPRI published data, the average home has 2-3 wiring errors, which generate significantly elevated power line frequency magnetic fields. This means that it's quite likely that you can reduce your magnetic field exposure by finding and correcting these simple errors.

How difficult is it to fix wiring errors? It is time consuming, but does not involve any expensive wiring changes. The only tools required are a 4-cell battery box, two alligator clip leads and a Volt-Ohm-Meter (VOM) from Radio Shack. These errors are most commonly the accidental connection of two different circuits' white wires (neutrals) together. This is indicated on the magnetic field meter as abnormally high readings in certain rooms when the lights or other electrical loads are on.

If you understand basic house wiring, you can do this yourself. If you don't, and don't feel that you can learn it, find a competent electrician or technician, or a handyperson who knows house wiring. I will now walk you through the process so you or your helper can understand it.

It is easiest to locate the source of the problem by using an Ohm meter (VOM) with a continuity test beeper at the power panel. This type of meter is $5-$25. Each neutral wire is continuity tested (beeps if low resistance) to each other neutral, after removing them all from the neutral buss (bare copper wires in a long bar with screws). The offending wires will beep when tested. Label each pair of white wires that beeped, because they are mistakenly connected together somewhere in the house. Then, trace each neutral (white) wire back in the panel to its black mate, and to the corresponding labeled circuit breaker. By reading the labels on the circuit breaker, we now know which two circuits' neutrals (white wires) are accidentally connected. We'll call this accidental connection of two circuits neutrals the "neutral short," and pretend that we've only got one to find, even though some homes will have 2 or 3 pairs of these "two neutral circuits connected" wiring errors. Turn off the circuit breakers to these two circuits.

Now for the time consuming part. Look for walls in common with the two circuits. Now open up every box in the common wall, and look for boxes with at least 3 (usually 4 or more) Romex cables - that would be 3 or more white wires in a plastic wire nut. Take off the wire nut and separate the neutrals. Now do a continuity check for your pair of neutrals back at the power panel. If you don't get a beep, you've found it! To identify which white wire is which, I hook a 4-cell battery pack from Radio Shack to one of the suspect neutrals (white wires) back at the power panel, connecting the negative lead to the ground buss. Using the VOM meter set to DC Volts, I can then identify the white wire with 6 Volts DC. I then move the battery connection to the other wire, and confirm it in the box. It is then easy to study how the two circuits go through the box, and separate their neutrals with an extra wire nut.

There! Now we've found and fixed your wiring error, and the large magnetic fields in that area of the house will be gone. This "all neutrals in one big wire nut" type of problem is the most common wiring error.

There are a few other types of problems. The easiest to find is closely related to the "neutrals shorted" problem we've just fixed. In this case two hot (black) wires from two different circuit breakers are connected together. If the two circuit breakers are on the same phase (both on an even circuit breaker number), this will not trip a circuit breaker. The only effect is that you will again have abnormally large magnetic fields when those two circuits are being used. This type of wiring error can be isolated at the power panel with a VOM. Turn off the main breaker. Do a continuity test between each circuit breaker's output screw, and all the other breakers. Mark any circuit pairs that beep. Finding the problem is just like the previous "neutrals shorted," but you will be trying to find black wires accidentally connected. This "two hot phases connected" problem is far less common than the corresponding "two neutral circuits connected".

Another common problem that causes elevated magnetic fields is related to grounding errors. These are not that complicated, but require a bit too much explanation for this article. I highly recommend "Tracing EMFs in Building wiring and grounding" by Karl Riley. Some of the more common problems are sub-panels which don't have separate, isolated ground and neutral busses with a separate ground wire from the main panel, and sub-panels which have earth grounding (ground rods).

Ground/Neutral Currents in the Earth

Ground/Neutral currents in the earth are a consequence of the Wye power distribution system grounding practice and can be extremely problematic for people with MCS/ES, more than a direct relationship of field strength would imply. It is unclear whether it is from higher frequency harmonics present in this situation, some low frequency component or whether it is interference with the normal 2 microgauss (0.002) 8.3 Hz (plus some higher and lower frequencies which make it look much like a human brain wave) biological frequency resonance (Schuman waves) of the earth. Schuman waves are caused by the "ringing" of the earth from lightning strikes around the world. In very rural areas where the magnetic fields from ground currents parallel to transmission lines can be observed with a coil, low noise, high gain amplifer and a battery

powered oscilliscope, the magnetic field caused by ground currents often looks like a ragged triangle wave. These fields can extend for more than 4 miles (to 2 microgauss) perpendicular to a 500KV transmission line, and are unusual in that the flow can be laminar through a deep aquifer such that the magnetic field is perpendicular to the transmission line and varies little over miles or area.

Neutral currents through the earth are caused by the grounding practice of the power company's Wye distribution system. Areas with Delta power distribution and no nearby Wye transmission lines have virtually zero ground current, and extremely low magnetic fields, often less than 1/100th of Wye served homes. As loads increase on a Wye system, an increasing percentage of the neutral current goes back to the power plant through the earth. According to one power line engineering text, this is up to 25% of the total current. In a typical suburban setting with Wye distribution, most of the ambient magnetic fields are caused by neutral current to earth (ground current), and through metallic water lines in the earth. The good news is that with a meter sensitive to 2 microgauss (0.002 milligauss) you can "see" the magnetic fields generated by ground currents, and can thus deal with the ones generated at your own home site.

In rural areas, by selecting a property at the end of a local power line extension, very low levels of neutral current to the earth (ground current) can be found. Also, living in an area served by Delta distribution lines can allow much more dense housing with minimal ground currents. In the case of Wye systems, it is important to avoid metal water lines in the ground, avoid metal cased wells and to not ground your well (use an industrial GFI unit). In the Wye system, every connection to the earth is another source of ground current. A fully steel cased well, grounded, is such a good (low resistance) earth connection that in many cases, a very rural setting may have as much stray ground current as a more suburban one. Only by using a meter sensitive enough to "see" these low level magnetic fields can you tell if a situation is good or bad.

Radio/Microwave Reductions

If your radio/microwave levels in the home are above –60 dBm using the HF detector, you should consider adding some affordable shielding. You can often locate the direction of the source by using your body as a shield with the antenna fully collapsed and held close to your stomach; the source is in the direction of your back when the levels are lowest as your body is now blocking the antenna. The HF Detektor has an excellent manual for its use. If your house has metal siding or aluminum foil vapor barrier, putting UV film and aluminum screens on the windows (inside or out) will usually reduce your levels by 20 decibals. This is like moving a few miles away from the source. The charcoal painted aluminum screens can be sun baked for a few days and don't have an oily smell which is hard to get rid of on the plain aluminum screen. For new construction, make sure you include a foil vapor barrier and Low Emissivity (Low E) glass. Aluminum foil is a great reflective barrier for radio/microwaves, and even the microscopically thin layer of metal in Low E glass is good for about 24dB reduction.

For homes with no metal in the wall, foil wallpaper will accomplish the same thing. Pure 1 mil (0.001") thick aluminum foil (heavy duty Reynolds wrap thickness) can be applied to the wall with wallpaper paste, wheat or cornstarch, sodium silicate, or diluted Elmer's white glue. Foil tape the seams for an even better barrier, then putty and paint or clay putty/paint the foil.

If you like, conductive paints are also available as a barrier that is best used on the outside. Buyer beware as far as chemical odors.

Suggested Lifestyle Changes

- Don't use wireless phones.

- Clean up your home EMF environment as much as practical. Keep all electronics unplugged or power switched off when not in use. Measure the EMFs in your bedroom, and monitor them monthly.

- Don't use cell phones except for emergency use only. Don't carry one that's on "receive" unless it is an emergency.

- Don't use a microwave oven. They all leak microwaves to some degree, generate very bad magnetic fields, and may cause sensitization to other microwave frequencies, such as nearby WIFI and digital cellular. Save your microwave tolerance for other unavoidable exposures. If you are severely memory impaired and use the microwave to avoid smoking/burning your home since it turns itself off after a programmed time, you can add a mechanical timer and relay to any electric stove so that it turns itself off after the set time just like the microwave oven. This simple, cheap modification has improved my quality of life greatly, as I previously would smoke my home almost monthly, regardless of reminders, timers etc.

- Don't use or spend time in an area with wireless networking.

- Computer use: Use sparingly. Forget plans of working by home via computer that will result in many hours a day exposure. If you already have serious disabling MCS you're very likely to have bad ES within a few months or less. Some will do better with an Apple notebook, with external keyboard and mouse, and the unit pushed back. A piece of Conetic (or other Mu Metal) alloy wrapped under the unit and up over the keyboard will help. Apple products seem to be quieter and lower emission, perhaps because they meet Euro standards.

- Many more seriously ill folks have severe 60Hz flicker problems, and most LCS displays are refreshed at 60Hz. Although there is less than 1% fade to white between refreshes (every16.67 milliseconds the screen is re-written), this is enough to badly affect many folks with MCS and ES. So some may do better with a conventional CRT refreshed at 85Hz despite the low frequency magnetic fields they generate. A mu-metal alloy box is commercially available and would be advised if a CRT is used. Mu-metal is a special hydrogen annealed nickel alloy with a high affinity for magnetic fields.

- "Cherry pick" electronics by using first your meter, AM radio and then paying attention to how you feel. By selecting equipment whose EMF "signature" is lower and avoids specific frequencies that bother you, you can achieve far better "compatibility" than in attempting to shield a bothersome piece of electronics. Using distance, limited time of exposure and practical shielding for "cherry picked" electronics to further reduce the risk of sensitization is also wise. Make sure it's really off when it's off with the AM radio. In some devices you may have to remove the battery when not in use.

Much of the popular folklore of MCS and ES is wrong, and it does great disservice to the new folks joining our ranks. Repeating the same wrong information often enough does not make it right. While the physiological mechanism for ES is a work in progress, the physics of electromagnetic radiation are well established in the electrical engineering field of EMC. We know also that ES folks become sensitized to frequencies that they are exposed to, with higher frequencies generally being worse. Most ES folks are both electric field and magnetic field sensitive, but mostly magnetic at the lowest frequencies. This matches what we could predict of the coupling of EMFs to the body, given our size

The green building philosophy of Baubiologie, from Germany, can enable substantial harm by promoting fear of metals. I also feel their system of measuring “body voltage” is unscientific and technically unsound. Their system of beliefs is not based on any biological or technical field of science, and has consistently been unhelpful (at best) to people I’ve talked to with serious disabling MCS or ES.

Through adherence to the principles of Baubiologie, as I write this, an elderly lady with MCS and ES is living back in the Northeast in a mobile home with a tarp for a roof. Her metal roof was removed based on a very expensive consultation with a Baubiologie “expert” who she says told her she’d never get well with a metal roof. The result is that she is only sicker and poorer. One MCS lady was told by another consultant to replace her gas boiler with an electric one, located downstairs from her bedroom and living space. Now she has high magnetic field exposures from it, is much sicker with ES, and paid anther Baubiologist $1500 dollars for a survey of her home’s “body voltages” and no magnetic field measurements at all. She also paid for shielded electrical cords and of course was not better, since her conventionally wired home had unshielded wires all around her. Due to the fact that drywall is virtually transparent electrically, putting shielded cords on the visible power cords is “wishful thinking”. (Electric field shielding is a good idea, via steel conduit, foil on the walls, or metal clad wiring.)

One popular misconception is that metal in and around a home is bad. The real problem with metal siding or framing is that it can become a current path for neutral current to the earth or an unplanned neutral current path, thus making a very bad electromagnetic situation. Metal is in fact very helpful, as it will provide good shielding from cell towers and other radio/microwave sources.

An example of this is a home I did some volunteer EMF mitigation work on that had a power panel bolted to the steel siding, which carried the neutral current around the house to a hose bib that was screwed to the siding, which led to a copper pipe running underneath the house. The entire home had a low level magnetic field from the neutral to earth current path, over 20 times the very low background level for this home. So while this is a common problem, blaming it on the metal siding is misleading. The solution was to find the path to ground, via the Trifield meter with 100X external probe, isolate the faucet from the siding with some plastic tape, and remove the screws. Metal that is not connected to the power company neutral is your friend.

Another false notion is that a metal roof will shield you from the earth’s natural field. This just isn’t so. Real measurements (done myself using my own DC field meter using an Allegra Microsystems sensor) of the earths DC field show that it is affected by 6% close to the walls, and 1-3% in living areas in a house with 26 guage steel siding, steel roof, and steel lathe (plaster walls, not drywall). This is an extreme amount of steel and still results in much less than the natural variation in the earth’s field by location. I remember one book where the author, an MD pioneer in environmental behavioral medicine, even raised concerns about use of steel nails in a wooden structure affecting the earth’s field. This is happily completely incorrect. It takes a surround of heavy steel or iron (or special metals like mumetal alloys or 5% silicon steel) to significantly affect a DC or low frequency magnetic field. The science of shielding materials effectiveness for various frequency electric and magnetic fields and distances from sources is well documented in the engineering field of EMC. Donald White’s “Electromagnetic Shielding”, Volume 3 is a great reference work in the field of EMC that has performance graphs for virtually all common shielding materials. While I never achieve quite as good a shielding result as his graphs indicate, I’ve found White’s book very helpful in selecting the right material(s) for particular shielding problem, with results that do track his modeled data.

The Schuman resonance of the earth is a naturally occurring, 2-3 microgauss (0.002 milligauss) AC magnetic field (on top of the earth’s 500 milligauss DC field) in the range of 3-16Hz with a peak of 8.3 Hz. The Schuman resonance is the “ringing”of the earth from lightning strikes. The frequency range of the Schuman waves are in the same range as human brain waves, or “biological frequencies”. Since these frequencies are so low, they are very difficult to shield. At best you might see an addition 1% shielding over the change in the earth’s DC field from your

metal surround. Most of the living areas away from steel clad walls will have 2-3% reduction. Near large windows or doors, zero reduction. Some exploratory research by a maveric researcher named Beck indicates that we are very sensitive to magnetic fields in the biological frequency range, but there has been no research yet to see if Wye ground currents have a biological frequency "undertone" or whether they interact with the natural Schuman waves.

The one situation where I have concern is the Lateri trailers built of heavy steel panels for walls, floor, and ceiling. I've measured one, and there was a 60% reduction of the DC field (similar reduction on the biological frequency Schuman waves can be assumed). On the other hand, the Lateri trailers provide the same 60% (not really enough to make a big health difference) reduction of power line/ground current magnetic fields. My guess is that even this is OK, though Lateri trailers aren't great for thermal and mold reasons and I would suggest avoiding them on those grounds. If you own a Lateri trailer, I'd suggest caulking the seams of the panels. The Polyken tape on the panel edges inside the wall is/was all that was sealing them, and it has certainly failed in some areas within a year. Additionally, mold in the wall cavity is very common from leaks and condensation once the foil has failed. Also do not connect the trailer ground to the power company ground. You want your walls connected to a low impedance (bunch of ground rods) earth ground that is completely isolated from the power company so that you are not constantly exposed to the higher frequency noise of the power company neutral, which often is pretty bad. You will also have bad ground currents if you earth (put in the ground via ground rod) the trailer ground without disconnecting it from the power company ground. The Lateri trailers I've checked were wired nicely in steel conduit and with separate ground and neutral busses, so it is easy to isolate the ground. This is a code violation but with sufficiently low impedence earth ground is safe.

Another popular myth is that metal will magnify various electrical fields. This is not true. Let's take a look at the real situation. If you have a house with ungrounded rebar or remesh in the floor, and you have a computer in one end of the house on a dedicated, shielded power circuit, and you are at the far end of the house, what is your effective distance from the computer? The simplistic answer is the distance from the computer to the floor, and your distance to the floor. The remesh/rebar steel will pick up and re-radiate a portion of the high frequency emissions from the computer. It is not really as bad as the simplistic answer use of some physics called "self inductance" of the rebar and "parasitic capacitance" of the concrete slab. The signals really don't travel down the rebar unattenuated. But of course the save conducted and re-reradiated emissions also apply to unshielded phone line, CAT5 cable, TV cable or power circuits. The remesh/rebar steel does not and can not amplify the emissions, but they can conduct them from one place to another. If the remesh/rebar is connected to the earth, there is less of a problem, but if it is earthed (via ground rod or pipes in the ground) and connected to the power company neutral, there will be a serious ground current problem with low level magnetic fields in the home. The fields from neutral connection to earth are particularly bothersome, perhaps from the high frequency component they typically exhibit, or from some interaction with the natural earth field aka Schuman resonance.

Another issue is the aluminum foil often used for vapor barriers. Does it amplify bad radio waves? No, but if you put a computer or digital answering machine or any electronics equipment inside a true Faraday cage, the high frequency emissions which outdoors would go in all directions will "rattle around" by reflection inside the building and you will see higher emission throughout the Faraday cage.. The emissions are not amplified per se, but it is as if you were closer to the source. Another potentially bad aspect of aluminum foil is that IF it is connected to the power company neutral/ground, it will be radiating the high frequency from the neutral as well as being low voltage AC. The foil needs to be isolated from the power co. neutral/ground, and preferably be grounded. The easiest solution is to isolate the house ground entirely from Wye power distribution system, while providing a very low impedance earth ground system. This is called a TT grounding system, and it is not used in the US, and is considered a code violation here. The totally isolated ground system (a series of rods) must be 0.2 ohms or better for this to

be safe, as the earth connection must be able to clear (trip the breaker) for any short to ground. . In a Delta wired area, special caution must be taken as the earth connection at the transformer may not be very good over time. An industrial GFI or similar active protection device should be considered for some Delta situations. (Contact the author.)

Foil used thoughtfully is very helpful for EMF mitigation, because the foil is providing electric field shielding of the house power and phone wires, and reflecting away outside radio and microwaves.

Metal sensitivity is very common with MCS folks, and ES folks as well. This is not an EMF issue as long as the metal is not connected to the power company neutral/ground or a hot wire. Any machinist will tell you that all metals have a distinct smell, and some can even tell a specific alloy (mixed metals) by the smell. The smell is caused by metal ions released at the surface, and some metals are like some relatively odorless chemicals to MCS disabled people- they affect you badly though you don't smell much of anything. So if you notice that if you are near a piece of (unconnected to power) metal and feel bad, don't blame EMFs. The good news is that virtually any thin coating will stop the flow of metal ions from the surface, even a clay paint, and even if you are sensitive to aluminum it is still possible to use it in a wall system, though not exposed. In cases of mild aluminum sensitivity, corroding the metal with a salt spray such that it develops a dull film of aluminum oxide on the surface is often sufficient. Likewise new low EMF EPA series hot water electric baseboard heaters from Cadet have new exposed aluminum and copper in them, and for mild metal sensitivity the salt spray can be used to get both the copper and aluminum oxidized quickly. (No salt on the wiring and rinse it well when done.) This procedure is done while doing the outdoor "bake out" of a new unit and has proven very helpful for many.

The best solution for MCS/ES folks is to use cleanly earth grounded foil barriers behind or on the wall surface to shield out the outside sources and remove EMI sources in the house so they aren't polluting the indoor environment.

If you aren't going to pay attention to neutral to ground issues, or clean up your interior electronics use, then yes, you might be better off building a metal free home. But given the huge increase in microwaves even in rural areas, and with power company power becoming "dirtier" all the time, you are far better off using foil and metal siding and with careful attention to neutral-ground paths and clean earth grounding of the foil.

To solve the EMF problems with steel siding, electrically isolate (don't let it touch) the power panel(s) from the metal structure. If you must have a code compliant Wye system, at least put a plastic coupler on any metal pipe entering or leaving the structure. Far better is to avoid any buried metal pipe. Keep power company "grounded" plumbing electrically isolated from any metal pipes in the ground or a ground rod via plastic couplers.

Another myth that drives me crazy: The house power should be well grounded, or that adding ground rods will reduce EMF problems. In Wye powered areas, adding ground rods to the power company neutral/ground will only cause increased ground currents and the nasty (higher frequency) magnetic fields that result. Only isolated earth grounding can be used in Wye served areas, and it must be done with great care for safety and to avoid creating ground currents from accidental connection to the power company neutral.

One of the worst examples of grounding induced EMF problems is in a semi-rural facility which has long been promoted for folks with severe MCS. There are about 15 units of either Lateri trailers or other trailers and porcelain structures. Each trailer/structure is provided a neutral and two hot wires. (For 220 and 110 VAC.) No ground wire is run to the trailers, which in itself is a code violation. The body of each trailer is connected to the power company neutral, and to a ground rod. This "ground rod farm" makes the site one of the best neutral to earth connections in the area, and the entire camp therefore has elevated magnetic fields from neutral/ground

currents. As air conditioners cycle on `and off in the campground, the neutral voltages shift with load and thus these transients are expressed as both magnetic field spikes and as electric field spikes in the bodies of the trailers which are connected directly to the neutral wire. I've met over a dozen people who've lived there for some time since I became disabled in 1988. Virtually all I've met have claimed to have developed ES while living there, though they did not know why.

Ground rods connected to the Wye system neutral create problems, they do not solve them. For any metal structure you are living in or around that's powered by a Wye distribution system, the structure should be isolated (disconnected) from the power company neutral and then grounded with a very low resistance ground rod farm (called a TT ground, not used in the US and not code compliant). If a very low (0.2 ohm) resistance ground cannot be achieved, whole house "GFI" technology or current sensing on the isolated earth ground can be applied to sense a short to ground and then clamp the isolated ground to the power company neutral to "clear the fault". Contact me in this case, as I've developed circuitry for this situation, which I call the "Active Isolated Ground Monitor" or AIGM.

The great satellite dish myth is that Satellite (receiver only) dishes are terrible EMI sources. This one can be more true than not.. Satellite dishes ARE a big problem for ES folks in packed suburban settings, but again, the problem is not because satellite dishes are terrible in themselves. The biggest radiation source is actually the cable leading to the dish, and the fact that the dish is active even when the receiver is "off", so it becomes a 24/7, sensitizing situation. The satellite receiver MUST be unplugged (or switched off with a power strip) to stop the radiation. This can be demonstrated with an AM radio tuned between stations, held near the cable to the dish while the receiver is "off". You will hear the cable's pulsing noise swamping the AM receiver as it is still active. When the power is unplugged or switched off to the satellite receiver and any electronics it's connected to, the satellite dish is once again a quiet, passive hunk of metal, incapable of generating EMI. But it is capable of producing a conditioned (and sometimes debilitating and painful) response in someone previously, repeatedly, tortured by a "dirty" dish. Once the problem is solved, this may fade with time.

The next step is to reduce the "on" emissions on the cable by earth grounding it back at the receiver with a ground block connection close to the receiver to a few ground rods. Earth ground it again at the dish, preferably with the dish post mounted on the ground, not up on the roof acting as a long antenna. This will not create neutral/ground currents, as the cable is almost always isolated by the switching power supply from the power company's neutral/ground. This is easily determined with your volt ohm meter (VOM) by measuring the resistance between the cable shield connector and the neutral wire of the two pronged plug. If it's not very high resistance, an isolation transformer must be used. The best, lowest EMI satellite dish setup also uses metal conduit to carry the cable from near the receiver out to the post-mounted dish. The location of the dish and receiver/cables are also important considerations, especially in a multiple person home. Ideally a separate, shielded circuit (steel conduit or metal clad wire) is used for all the entertainment electronics so that other rooms are less affected. Drywall interior walls without foil are virtually transparent to both magnetic and electric fields from the receiver and attached cables.

Another popular myth: metal must be grounded to provide shielding. Untrue. An ungrounded metal enclosure will provide shielding for most frequencies except for those corresponding to the wavelength of the enclosure's length and height. Since the enclosure is resonant at those frequencies, they will pass through unimpeded, though they will not be amplified. Grounding will tend to eliminate those frequencies as well, but will change the enclosure's resonant frequency so that there may be some new frequencies which will be less effectively shielded. In situations where I am shielding electronics for an ES person, I will usually ask them to try it with the shield grounded and not grounded, and select the preferred configuration. I recommend grounding of foil in walls because there is considerable capacitive coupling of "dirty power' (high frequencies) from the wiring in all the walls to the foil. Most of the time the grounded configuration in this

situation is preferable. Earth grounds which are connected to the power company ground/neutral will cause large area, low level magnetic fields from the neutral current flowing through the earth. When we ground or "earth" something, it must be totally isolated, and for safety it must have a good enough earth connection to be able to quickly pop that circuit's circuit breaker.

Quackery of the Magic Pendant

There are a large number of products sold for which claims are made that they'll provide protection from the bad effects of EMFs. I have checked out many of these products. They are all completely ineffective for electrical sensitivity and are generally utter baloney. They may work for a short while by a placebo effect.

One company makes a unit that looks like a digital clock. It was given to a friend at an AAEM conference where the company was selling their products to physicians, using impressive sounding techno-babel. My friend was given a unit which did not help her in high EMF places like an elevator, but brought the device home, and let me test it. The clock generated bad magnetic fields from the internal transformer, just as any normal clock would. It was immediately bothersome both to me and another ES disabled person who tried it. I measured its output with my own equipment, and saw nothing but the emissions of a digital clock; the magnetic field of a transformer hooked to a DC power supply; and the higher frequency emissions of a digital display (which are pulsed/strobed, being refreshed constantly) that are easily heard on an AM radio.

I got suspicious, so opened it up. (My general policy is that complete disassembly and detailed inspection is a normal part of any product inspection.) Surprise, the only thing that wasn't a standard $15 clock radio was the label and price. I looked up the clock chip (they hadn't even bothered to file the letters off it) and found it was a Motorola part that is not programmable. There was NO other circuitry except the power to this chip and an exact copy of the chip interface circuit listed in the Motorola applications info for this chip.

I checked every component. I then called this company and asked about this product. First I was told it had a custom programmed chip. I explained that the chip was NOT a programmable part. (I had worked for Motorola Microsystems, worked closely with their semiconductor division and was quite familiar with Motorola's semiconductor products.) Then I got an outrageous story about how the chip was not programmed in the "conventional sense", that instead it had "ingrams" impressed on it from a device that "looked like a microwave oven". Ingrams are the science fiction "patterns of thought" recorded electrically that appeared in the first Star Trek series. (There is no way to reprogram a non-programmable semiconductor device.)

These types of products which don't produce measurable reductions in EMFs work only by the power of suggestion and placebo effect. They are nothing but a cheap standard product with a label and a lot of marketing hype. This includes various forms of "crystals" and a pretty pendant, which is nothing but a defective semiconductor wafer circled by a loop of wire, which is unconnected to the "chip", is not powered, nor is it connected to the chain.

One company presents a non-peer-reviewed "study" from a very alternative medicine magazine that alleges to show how their labels on standard products really work. Needless to say, these "studies" were not peer reviewed or evaluated by a decent EMC engineer who had actually looked inside their "product". Plenty of smart folks including a bunch of alternative medicine doctors have been fooled, so don't feel bad if you've been fleeced. If you weren't familiar with the electrical engineering field of EMC and electrical sensitivity, it would be easy to be fooled by their impressive technical sounding materials. Alas, it is science fiction, not quantum physics, and the products are only effective as an anxiety reducer for electro-phobia related anxieties. I feel that other legitimate anxiety reducing therapies would be more productive in the long term.

There are also some psychics who make claims about "earth's lay lines" and claim to sense disturbances in the earth's field, which they change by burying a blue plate or other such voodoo.

There are also crystals, “diodes” and “polarizers”, stones that you bring into your car. Don’t get fleeced by these charlatans. They wouldn’t know a bad ground current problem if you showed it to them. If these things have worked for you, even if only for a short while, be encouraged instead of mad. Real stress reduction therapy, including meditation or prayer, is likely to give you more lasting help for the anxiety relating to your ES. ES isn’t caused by anxiety, but you’d have to be nuts not to have some anxiety after you have ES or MCS because the world around you really does make you ill. As in MCS, reducing your overall EMF exposure while preserving as much quality of life as possible is the only effective treatment for ES.

Note: Bruce is an Electrical Engineer (Computer Science) and former engineering R&D manager, who became disabled with severe MCS and later, ES along with MS and epilepsy.