# Sarah Seguin on EMPs and How to Protect Your Data

https://mindmatters.ai/podcast/ep146

Robert J. Marks:

Welcome to Mind Matters News I'm your amiable host, Robert J. Marks. Greetings. EMPs are electromagnetic pulses, come from lightening, the sun nuclear explosions and man-made weapons. We hear about EMPs disabling electronics. We hear that your cell phone would be wrecked and your car would be disabled because of the electronics would be fried. And I tell you as an electrical engineer, not specializing in this area, the more I look into this, the more concerned I become. Our guest today to talk about this is Dr. Sarah Seguin. She is an expert in the area of electromagnetic compatibility. Dr. Seguin was formerly on the faculty at the University of Kansas, she then developed the software business, Third Iron, and now is doing research at Baylor University. Sarah, welcome. Welcome to the podcast.

Sarah Seguin:

Thank you very much. I'm really excited and happy to be here. I appreciate the time.

Robert J. Marks:

Oh, this is great. I think that we're going to scare a lot of people don't you?

Sarah Seguin:

Well, I think that knowledge is power and not necessarily scary.

Robert J. Marks:

Okay. Yes, I guess that there's truth in that also. You know, both you and I are electrical engineers and we are pretty diverse. The field of electrical engineering is well, in our parents society the IEEE the Institute of Electrical and Electronic Engineers has, I have to say this over 400,000 members and it's divided into numerous individual specialty societies. And one of them dealing with EMPs is subsumed in the society dealing with electromagnetic compatibility. Now you're in that society, you have held office in the IEEE electromagnetic compatibility society and the study of EMP technology lives in the society. Before talking about EMPs let's be a little bit more general and just define what electromagnetic compatibility is and why electrical engineers need a separate society to study electromagnetic compatibility. Could you describe the general field of electromagnetic compatibility?

Sarah Seguin:

Yes, I'd be happy to. It's a very large field and a note that I am currently Chair of the Spectrum Engineering Committee, TC 6 subcommittee of the IEEE society, electromagnetic compatibility. So EMC, I always like to describe it the best when I was teaching the class at Kansas, basically electromagnetic compatibility is based on the fact that all active devices radiate electromagnetic energy. And the fact that I am talking to you through my computer and I have a cell phone right next to me and my microphone is working, and everything is just working seamlessly is electromagnetic compatibility. And it's, non-trivial. Basically all of these devices by just simply being turned on, radiate electromagnetic energy, and then this electromagnetic energy, we want it to not interfere with other devices.

Sarah Seguin:

A very good example of an electromagnetic compatibility issue that generally we've decided not to fix because it's for cheap speakers is I think all of us have set our cell phone next to an inexpensive speaker. And right before it rings, or maybe before we receive a text message, you hear a little bit of buzz, right? Well that's because those speakers aren't shielded against that energy that is being induced within that circuit from your cell phone. Now, of course there's expensive speakers that can handle this, but the generally cheap computer speakers, et cetera, can't. So electromagnetic compatibility is basically the fact that we take for granted that all of our devices work together when we turn them on and there's no interference.

Robert J. Marks:

So a specific type of electromagnetic compatibility is the EMP, the electromagnetic pulse. What are EMPs and maybe you could discuss some of their sources?

Sarah Seguin:

Well, one of the biggest and most well-known sources for electromagnetic pulses are nuclear detonations. So of course, a nuclear detonation it has all sorts of physical issues. But before, and when they were testing the nuclear bomb, originally a nuclear detonation in the mid 1940s, it was discovered that semiconductor devices that were used to monitor these effects were actually destroyed, but they weren't actually destroyed by the physical blast. They were destroyed by the electromagnetic pulse that comes before the blast. Another source of electromagnetic pulses is lightning. And of course we can have created electromagnetic pulses. There have been some governments that have been working on that as well that had been in the news recently.

Robert J. Marks:

Okay. Now we hear that electromagnetic pulses fry or electronics, zap our electronics. What's the physics behind this? What is going on that a electromagnetic pulse can disable your cell phone or your car or something like that?

Sarah Seguin:

Well, again, it comes back to the whole electromagnetic compatibility issue here and how hardened your device is. So what happens is you have a very intense or powerful electromagnetic wave that's emitted from, for example, a nuclear detonation or it could be created with electronics and a directional antenna. So then this intense electromagnetic wave basically causes current to be induced within the device.

Robert J. Marks:

I've always heard that, for example, your AM radio is a result of electromagnetics being transmitted at the transmitter and you receive it. So it induces a current in your radio.

Sarah Seguin:

Yeah, that's exactly what happens with AM radio, FM radio, all of it. You're inducing current on the antenna that's receiving it. So an electromagnetic pulse is really just like a really strong transmission that's inducing currents on your electronics. Unfortunately, it's in a way that we don't like, and the electronics generally aren't hardened for this or expect it. Cause it could be, antennas are definite

problem places where a device could be vulnerable to EMPs. But in addition, just like, for example, if you think about a circuit board where there's a long trace to run current across, EMPs could also induce currents there.

Sarah Seguin:

Now inducing currents on a particular conductor is not necessarily the problem. The problem is when the semiconductors aren't rated for those level of currents that are induced, and then could actually physically cause these electronics to fry. Like in the case in the early 1940s, when they discovered what was happening in their nuclear detonation tests or mid 1940s.

Robert J. Marks:

You know, in prepping for our conversation here, I read that in Enrico Fermi actually anticipated this and asked people to cover some of their electronics prior to the Manhattan Project explosion. Which I thought was very insightful. Let's talk about EMPs at a personal level. If an EMP goes off, we hear these fear things; will it fry my cell phone? Could it cut off communication between cell phones? In other words, screw up the infrastructure of communications. Would it disable my car? Would it erase my flash drive or my computer memory? Are all of these true or some of them are true?

Sarah Seguin:

Well, they could be true. It all depends on your proximity to the EMP. Because of course we know that the wave propagation decreases, right, the further away that you get from the source of the EMP. So if you're right next to the EMP, say a cell tower or your cell phone, your house, or for example, a lightning strike creates electromagnetic pulses to another, that's a natural occurrence of electromagnetic pulses. If you are right next to it, especially if your devices aren't hardened to it for a lightning, for example, if it can conductively go through your power system and you don't have protection through surge suppressors, then the answer is yes. But from a whole system standpoint, could it completely bring down an entire area? Well, it really depends on the strength of the electromagnetic wave that is the electromagnetic pulse.

Robert J. Marks:

Okay. Yeah. You've spoken a couple of times about hardening the electronics. How do you protect your electronics? You hear that there's a bomb which is going to go off that's going to generate an electromagnetic pulse. What do you do with your cell phone to protect it?

Sarah Seguin:

Well, you would want it to be preferably in a shielded room, but I don't know about you I don't have a shielded room hanging around my house.

Robert J. Marks:

One thing that somebody suggested to me is microwave ovens. You know, microwave ovens are surrounded by a shell, a so-called Faraday cage, I believe that keeps the microwaves in. I think it should also keep the microwaves out. So I might go and put my cell phone in a microwave in order to protect it. And try to remember not to turn on the microwave oven while it's in there.

Sarah Seguin:

Yeah you could definitely hurt your electronics and your microwave, but actually that's not a bad idea. Microwave ovens though are designed to specifically shield at the frequency, the resonance of water, because that's how they work. So it's 2.45 GHz. And so in general it would probably do a pretty good job if you were far enough away from the EMP. So if it shields for 2.45 GHz, that means that you shield based on the wavelength. So 2.4 GHz, the wavelength is about 12.5 centimeters in general the rule of thumb is you make the aperture, or the holes, this the largest size. For example, you can all look into your microwave about a quarter wavelength of that. So in general, that's for the highest frequency so it would be protected for everything lower as well. In general, you can assume that. And so I think putting it in your microwave oven, it could be a really good choice for your cell phone provided that other infrastructure survives.

Robert J. Marks:

One of the solutions I've also heard for protection is insertion of surge devices, surge protectors. The idea is that it's the quick change of the electromagnetic pulse that does a lot of damage maybe by using surge detectors, you could protect your electronics. Is that true?

Sarah Seguin:

Yes, it is definitely true, but you'd have to think about how the search suppressor, what it's protecting against. So the surge protector is protecting against energy that comes from your outlets or some cases people have whole house search suppressors, some laboratories have building surge suppressors. And so that assumes that, for example, the electromagnetic pulse or lightning which has also got all those frequencies, it's an electromagnetic pulse of sorts. It induced current onto the power lines, and then it's means that these search suppressors are protecting against the large current that has been induced on the power lines from getting to your device and then therefore causing a damage through its power supply.

Robert J. Marks:

So this would only work if there was an EMP explosion and it affected a power station that generated a surge on the line. If you were directly in the path of the EMP, it would fry your electronics and your cell phone directly. Is that right?

Sarah Seguin:

That's correct. Or it could. That is the part of the study of electromagnetic compatibility, coming back to that, is figuring out where devices are vulnerable. That's a whole study. And then basically hardening them where they're vulnerable. So for example, your cell phone is probably going to be more vulnerable at the frequencies that it receives. So it receives wifi at about 2.4 GHz, so depending on how close you are and how much of that frequency is in the electromagnetic pulse, for sure you could definitely. If you're in the direct path of that intense radiated electromagnetic energy, your devices could definitely be fried without being coupled through the power line. It just depends on where the energy is coming from.

Robert J. Marks:

Would an EMP destroy a flash drive, do you know?

Sarah Seguin:

An EMP could destroy a flash drive. More likely it probably won't destroy the specific data that's stored, but it could destroy the electronics in which case you'd have to fix the electronics to recover the data. So for all intents and purposes it is destroyed, the data.

Robert J. Marks:

Okay. You know, I was having a conversation. I believe this was with a guy with Microsoft and we were talking about the best way to store files. And it used to be you used little floppy disks and then these floppy disks, you had USB ports that could have up to a gigabytes on them. And now you can get them a terabytes on Amazon.com. And I found out that I tried to store some of my stuff on such devices. I went back in a year or two and it was totally unreadable, I don't know where it went, but it just destroyed. And then along came, read writeable, CDs, and DVDs and I tried to store a lot of stuff on those and that also in a couple of years turned out to be no good. And he said that the best place probably to store your stuff is on the cloud. And I'm wondering, and I don't know, you probably don't know either whether the cloud is protected from these EMPs.

Sarah Seguin:

That's a really excellent question as a co-owner of a software company that he is in the cloud. I have a little knowledge of the cloud, but I'm by no means a software engineer or a data center engineer. So what's interesting about the cloud is that in general they have distributed data services and these distributed data services means that your data is not in any one place. And so by storing your data in the cloud, an EMP would have to capture everywhere that your data is. So it would be unlikely. And in general, these data centers, I know for Amazon AWS, I think there's one in Virginia. In general, (or at least somewhere out east) these data centers do have quite a bit of protection and security.

Sarah Seguin:

Now is your data safe from hackers? That's a different question for a different podcast, but your data would be more protected from electromagnetic pulse by storing it in the cloud. That's that's for sure.

Robert J. Marks:

Yeah. I heard this too, that Microsoft has three centers or more, three or more centers and they would have it on the east coast, the west coast and in the south, I should've looked this up, but I didn't. And that there is a redundancy there. And that if you lose one of these sites while you can still regain your information from another site, so they might be doing that instead of electromagnetic compatibility hardening, it's just a thought.

Sarah Seguin:

I think they do a little bit of both. I have known folks who work for IBM, who work in their data centers, they also have big data centers in the cloud as well. And in general, they are concerned about electromagnetic compatibility. They do employ EMC engineers. I know folks who work there or have worked there. And so they do harden them a bit just by the fact that these really industrial servers just need to be hardened to work in a large room with a ton of servers. So it's kind of a combination, but I imagine they don't necessarily have like military protection if you will.

Robert J. Marks:

Okay. Well, thank you, Sarah. I think at a subsequent podcast, the next podcast that we do, I'd like to talk to you about the electric grid, but we'll save that till next time. Thank you, this has been very

informative. Thank you very much. Sarah. Our guest today has been Dr. Sarah Seguin, an electrical engineer who specializes in electromagnetic compatibility including EMPs. So until next time on Mind Matters News be of good cheer.

Announcer:

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