Another EMC resource
from EMC Standards

EMI Stories 571 to 665

Helping you solve your EMC problems

9 Bracken View, Brocton, Stafford ST17 0TF T:+44 (0) 1785 660247 E:info@emcstandards.co.uk

EMI Stories 571 to 665

571) EMI appears as error in calculation

This story is a relatively early one, from the development of the LEO computer. The quote is in the words of Mary Coombs, née Blood, who was the first female programmer on the software team.

“The engineers found us invaluable in helping to find faults. I remember spending hours and hours in the computer room – you could make little loops of instructions and put them in manually straight from the control desk. There was one fault that took us hours to track down – and it turned out to be electrical interference from the lift in WX block, the building in which LEO was housed. It didn't come out as a crackle like on the radio, it came out as something going wrong with a calculation.”

The date of the event is not very clear in the book; probably 1951 or 1952. Source: Georgina Ferry, A Computer Called LEO, Harper Perennial, 2004, p. 107.

(Kindly sent in by Richard Pickvance, Engineer's Eye, London, on 8th February 2010.)

572) Radar interferes with early computer

Here's another early EMI anecdote, about Australia's first home-grown computer, the CSIRO Mark 1:

“Other problems proved more challenging than just keeping cool. One was the appearance of random digits in the acoustic-delay memory. The researchers were helped in tracing this one by realizing that when the random digits appeared they were spaced three seconds apart. After some head-scratching they found that a meteorological radar mounted nearby was rotating at one-third of a turn per second. Each time its signal passed the air-conditioning duct on the roof, some of it was reflected down into the guts of the machine. A suitably high-tech solution was found – the mouth of the duct was covered with fine-mesh chicken wire that appeared impenetrable to radar of that wavelength, but didn't impede the flow of air.”

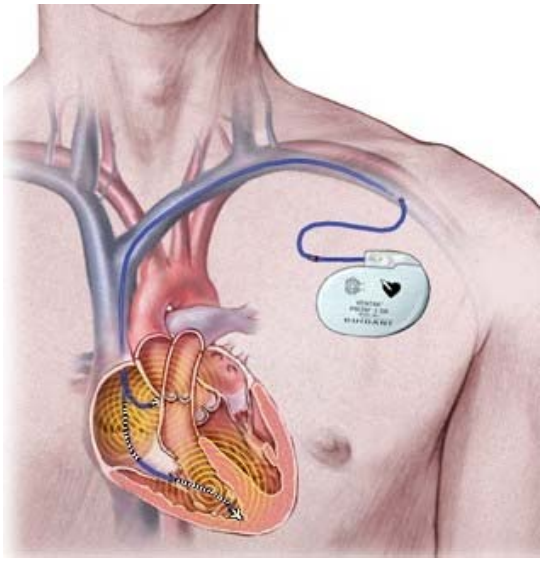
Again the date is unclear, but certainly early 1950s, probably 1951 to 1953. Source: Mike Hally, Electronic Brains: Stories from the Dawn of the Computer Age, Granta, 2006, pp. 171-2.

Somewhere I know I saw an account of life with a very early computer -- either Colossus or another not much later -- along the lines of “At some point in the small hours there was a loud explosion. Afterwards [the computer] worked considerably better than before.” Not a banana skin, but a good story anyway. I'll keep looking.

(Kindly sent in by Richard Pickvance, Engineer's Eye, London, on 9th February 2010.)

573) RFID Tags Could Affect Pacemakers and ICDs

Background: The use of radiofrequency identification (RFID) systems is expanding and highlights the need to address electromagnetic interference (EMI) to implantable pacemakers and implantable cardioverter-defibrillators (ICDs).



Objective: This study sought to examine the electromagnetic compatibility (EMC) between RFID readers and implantable pacemakers or ICDs.

Methods: During in vitro testing, 15 implantable pacemakers and 15 ICDs were exposed to 13 passive RFID readers in 3 frequency bands: 134 kHz (low frequency [LF]), 13.56 MHz (high frequency [HF]), and 915 MHz (ultra high frequency [UHF]).

Results: While being exposed to LF RFID, a reaction was observed for 67% of all pacemaker tests (maximum distance 60 cm) and 47% of all ICD tests (maximum distance 40 cm). During HF RFID exposure, a reaction was observed for 6% of all pacemaker tests (maximum distance 22.5 cm) and 1% of all ICD tests (maximum distance 7.5 cm). For both pacemakers and ICDs, no reactions were observed during exposure to UHF RFID or continuous-wave RFID. Pacemakers and ICDs were most susceptible to modulated LF RFID readers.

Conclusion: Although there is in vitro testing evidence for concern for implantable pacemaker and ICD EMI at LF and HF, the FDA has not received any incident reports of pacemaker or ICD EMI caused by any RFID system. We do not believe the current situation reveals an urgent public health risk.

(From HeartRhythm Journal: www.heartrhythmjournal.com/article/PIIS1547527109011461/fulltext, reported in Interference Technology's on-line newsletter www.interferencetechnology.com/lead-news/article/study-rfid-tags-could-effect-pacemakers.html.

574) Two infusion pump malfunctions apparently due to cellphones

MDR # 679280, Received 21 February 2006

The facility reported an infusion pump with over infusion. Reportedly a displayed rate changed during pt infusion. The pt's cell phone rang and the nurse at the bedside noticed that rate of pitocin was displayed at 120ml/hr rather than the prescribed rate of 20 ml/hr. The change was noticed in less than one minute and there was no harm to the pt. A new pump was put on the pt.
According to the hosp. rep, the event history did not show any buttons being pressed for the rate change.

MDR # 736554, Received 19 June 2006

The facility reported a pump that stopped infusing during patient use. The pump was infusing heparin, at which time the patient's family member used a cell phone in close proximity to the pump. The pump then stopped infusing. There was no patient injury or medical intervention according to the hospital rep.

(Presented by Jeff Silberberg (US FDA) to the 20th Annual AAMI/FDA International Conference on Medical Device Standards and Regulation, March 9, 2010.)

575) Interference between two medical devices means recall of one of them

Model X Extracorporeal blood circulation system. Recall date: March 17, 2008, No: Z-1902-2008

Recall reason: Use of Model Y Electrocautery Unit on the patient can cause Model X to stop pumping and alarm.

(Presented by Jeff Silberberg (US FDA) to the 20th Annual AAMI/FDA International Conference on Medical Device Standards and Regulation, March 9, 2010.)

576) New-generation mobile phones interfere with critical-care medical equipment

A total of 61 medical devices in 17 categories (27 different manufacturers) were tested and demonstrated 48 incidents in 26 devices; 16 were classified as hazardous, 20 as significant and 12 as light.

The GPRS-1 signal induced the most EMI incidents, the GPRS-2 signal induced fewer and the UMTS signal induced the least. The median distance between antenna and medical device for EMI incidents was 3 cm (range 0.1 to 500 cm). One hazardous incident occurred beyond 100 cm (in a ventilator with GPRS-1 signal at 300 cm).

(From:" Interference by New-Generation Mobile Phones on Critical Care Medical Equipment", van Lieshout EJ, van der Veer SN, Hensbroek R, Korevaar JC, Vroom MB, Schultz MJ., Crit Care. 2007;11(5):R98, Jeff Silberberg (US FDA) to the 20th Annual AAMI/FDA International Conference on Medical Device Standards and Regulation, March 9, 2010.)

577) RFID interferes with critical-care medical equipment

In 123 EMI tests (3 per medical device), RFID induced 34 EMI incidents: 22 were classified as hazardous, 2 as significant, and 10 as light. The passive 868-MHz RFID signal induced a higher number of incidents (26 incidents in 41 EMI tests) compared with the active 125-kHz RFID signal (8 incidents in 41 EMI tests). The passive 868-MHz RFID signal induced EMI in 26 medical devices.

(From: "Electromagnetic Interference from Radio Frequency Identification Inducing Potentially Hazardous Incidents in Critical Care Medical Equipment", van der Togt, R., E. J. van Lieshout, et al, JAMA 299(24): 2884-90, 2008, Jeff Silberberg (US FDA) to the 20th Annual AAMI/FDA International Conference on Medical Device Standards and Regulation, March 9, 2010.)

578) EMC of Pacemakers and ICDs exposed to RFID readers

Implantable Pacemaker Reaction to RFID

At least one reaction was observed in 21 of the 22 pacemakers tested. While being exposed to each of the two 134 kHz RFID readers a pacemaker reaction was observed for 34 of the 44 possible tests (77%). While being exposed to each of the four 13.56 MHz RFID readers a pacemaker reaction was observed for 21 of the 88 possible tests (24%).

Implantable Cardioverter Defibrillator Reaction to RFID

At least one reaction was observed in 18 of the 19 ICDs that were tested. While being exposed to the two 134 kHz RFID readers an ICD reaction was observed for 27 of the 38 possible tests (71%). While being exposed to the four 13.56 MHz RFID readers an ICD reaction was observed for 8 of the 76 possible tests (11%).

(From: "Electromagnetic Compatibility of Pacemakers and Implantable Cardiac Defibrillators Exposed to RFID Readers", Seidman S, Ruggera P, Brockman R, Lewis B, Shein M., International Journal of Radio Frequency Identification Technology and Applications, Vol. 1, No. 3, 2007:237-246, , Jeff Silberberg (US FDA) to the 20th Annual AAMI/FDA International Conference on Medical Device Standards and Regulation, March 9, 2010.)

579) The strange case of the energy-saving lightbulbs and Virgin Media

Got a Virgin set-top box with a mind of its own? And energy-saving lightbulbs? Then you might find there is a surprising connection. Emma Clements was advised to switch bulbs when her TV kept changing channels.

If your television or cable equipment seems to have a life of its own, why not get rid of your lightbulbs? It might sound like a joke, but that's the advice Virgin Media gave to Emma and Alistair Clements when their cable TV receiver started behaving oddly.

The couple, who have two young daughters, have been Virgin Media TV subscribers since moving to their home in Carshalton, Surrey, in 2007. They had no problems with the service until a few months ago, when they first noticed their Virgin Media set-top box, manufactured by Samsung, started randomly changing channels and switching itself on and off.

"At first we thought it was the children's sticky fingers on the remote control and that the buttons were sticking," Emma says. "But the novelty soon began to wear off."

Emma called Virgin Media customer services, which promptly dispatched a technician to examine the box. "Before he'd even seen anything, the engineer asked us if we used Philips energy-saving light bulbs," she says. "He changed the box anyway, but said it would probably keep happening."

Unfortunately, the engineer's prophecy proved correct. "With the new box, it was worse, if anything," Emma says.

The Clements family had only one Philips energy-saving bulb in their living room, in a lamp sitting on a side table about 12 feet away from the TV.

A Philips Electronics spokeswoman confirmed the problem was known to the company, but expressed surprise users of its bulbs still experienced it. "Some very early compact fluorescent lamps, shortly after starting, could cause interference with TV controls due to the frequency of operation of the bulb and when placed near a TV," the spokeswoman said. "The frequency was quickly changed many years ago and we have had no recent reported incidents."

Following Guardian Money's intervention, Philips's customer relations team contacted the family and asked them to return the offending bulb so it could properly analyse the problem, but said it wanted to monitor the issue on "a case-by-case basis". It advises other customers experiencing similar problems to contact its online support team. Virgin Media also acknowledged the problem but laid the blame squarely at the door of the bulb manufacturer. "This is an old problem," its spokesman said. "Some compact fluorescent bulbs flicker at such an imperceptible rate that they can interfere with infrared equipment. What our customer care chap said is kind of correct, but it's not the full answer. You can still use energy-saving bulbs, but we recommend trying an alternative brand."

Removing the offending lightbulb from the living room has helped, says Alistair, but the main light in his hallway still causes the set-top box to function erratically, despite being in a different room. "It's Virgin's box that causes the problem as much as the bulbs," he claims. "Energy-saving light bulbs aren't cheap. If we need to replace them all, why can't Virgin Media pay for them?"

The cable provider's spokesman denied the problem happened any more frequently with its Samsung boxes than others, but a browse through specialist cable TV forums online suggests it may be a more common issue than Virgin thinks – or cares to admit.

On cableforum.co.uk, a poster called Organ Grinder writes: "My light switch is controlling my Virgin TV box each time it is used … anyone have any idea what is going on? Is my flat haunted? … I don't think it's worth calling Virgin, as I understandably expect them to think I am raving mad." Monkey2468, a poster who lists his occupation as a technician, replied: "It will be energy-saving light bulbs. Seen it several times before with Samsung set-top boxes."

In the meantime, be it the fault of the box or the lightbulb, the Clements family just wants its TV to work properly again. "It would be very nice to get it sorted," says Alistair. "Virgin Media isn't particularly cheap and if we can't get it fixed soon, it might be time to switch provider."

(Kindly sent in by Matthew Wilson, Product Design & Production Manager, GB Electronics (UK) Ltd., "The strange case of the energy-saving lightbulbs and Virgin Media", Graham Snowdon, The Guardian, Saturday 10 April 2010 , www.guardian.co.uk/money/2010/apr/10/energy-saving-lightbulbs-virgin-media. This article appeared on p1 of the Money section of the

Guardian on Saturday 10 April 2010. It was published on guardian.co.uk at 00.06 BST on Saturday 10 April 2010."

580) Gas clothes dryer overheating incidents due to internal ESD

A model of gas clothes dryer was recalled in 2008, after seven reported complains that the dryers scorched clothes in them. The dryers were products of a well-known Japanese manufacturer, and 50,000+ units were shipped between 1997 and 1999. The cause of the incident, as I read from the announcement, is:

Clothes in the dryer's rotating drum caused ESD, and the ESD caused malfunction of a microprocessor which control the dryer. Then, the dryer's gas burner continued to heat the drum when the drum stopped rotation, caused overheating and scorched clothes in the drum. In all the known cases, temperature fuse in the dryer worked as intended and possible fire hazard could be prevented.

I don't know whether the product went through IEC/EN 61000-4-2 ESD tests. However, because the problem was caused by ESD inside the product and not by ESD outside the product as usually tested, and because maybe clothes dried and rubbed in the dryer could cause discharges stronger than that usually applied in ESD testing, I think we shouldn't be surprised even if product perfectly passed the IEC/EN 61000-4-2 tests still caused this type of ESD problem.

Reference: Recall notice from METI, http://www.meti.go.jp/product_safety/recall/file/080909-1.html

(Kindly sent in by our long-term correspondent in Japan, Tomonori (Tom) Sato, on 14th February 2010 http://homepage3.nifty.com/tsato/.)

581) Lubbock airport ILS suffers EMI, stops flights

There's a chance Lubbock Preston Smith International Airport will resume full service today, nearly a week after problems with the instrument landing system forced numerous flight delays and cancellations.

A Federal Aviation Administration flight check airplane is due to arrive today from Oklahoma City to test the airport's one working instrument landing system, which is essential for flights arriving in poor visibility.

An FAA spokesman said the system's equipment is operating correctly, but was being hampered by interference along the approach path. "It appears there is some electromagnetic and radio interference," said Lynn Lunsford, an FAA spokesman. "There was a spurious radio signal in the vicinity of the final approach path, doing just enough to cause our signal to be erratic."

FAA workers spent the weekend using radio and electromagnetic direction finding equipment to find possible sources of the interference. "We're reasonably confident we've identified the issue, but in aviation, 'reasonably confident' is not good enough," Lunsford said.

While he could not be specific about what was interfering with the ILS signal, he said causes could include unshielded electric lines or even a fluorescent light fixture with a ballast that is going bad.

FAA officials hoped to test the system Monday, but bad weather in Oklahoma City in the morning kept their airplanes grounded, Lunsford added.

Even if an airplane had been able to leave Oklahoma City, the weather at the airport Monday was not good enough to allow the tests. The flight check aircraft makes several passes along the airport's glideslope – the route an airplane would make on its final approach – to check the ILS signal.

Lubbock's airport has two ILS operations, but one is currently disabled because of runway construction. The airport also has an RNAV - area navigation - system that has allowed some carriers to keep flying.

Of the air carriers using Preston Smith, the situation has been hardest on Southwest Airlines, which has the most flights daily in and out of Lubbock. Southwest's airplanes are not equipped for RNAV.

(Kindly sent in by Dennis D. Swanson, Electromagnetic Effects Staff Engineer - Specialty Engineering Group, Lockheed Martin Mission Systems & Sensors, St. Paul, Minnesota, USA, taken from: "Landing system may be up today", by Walt Nett for AVALANCHE-JOURNAL, Tuesday, February 09, 2010, http://lubbockonline.com/stories/020910/loc_560323567.shtml. Story last updated at 2/9/2010 - 12:17 am.)

582) Bill includes $800,000 for military EMI solutions

The U.S. Senate passed the $636 billion Department of Defense appropriations bill that includes millions of dollars for military-related projects by Michigan companies, including an allocation of $800,000 for research and development of optical interconnect technology for military aircraft.

The next generation data and communication management systems needed for weapons platforms will depend upon tightly integrated optical fiber solutions, which reportedly provide decreased weight, immunity to electromagnetic interference and other advantages.

(From: www.detnews.com/article/20091220/POLITICS03/912200301/1022/U.S.-Senate-OKs-bill-that-benefits-some-Michigan-companies--jobless, 12/22/09 01:49 PM.)

583) PCB's solder resist layer causes hum interference problem

Over the years, I have improved the way we build our audio induction loop power amplifiers. When one niggle became unacceptable, I would try various means of dealing with it, then employ the best one.

Of interest to EMC design, I inherited the ancient strategy of star-wired earths, including several parallel earth tracks on the same power supply circuit board. My first revision of the power supply board was more like a transmission line from a.c. in to d.c. out, with one substantial earth track along the middle.

More recently, we have used a combined PSU and power amplifier board, with 2 power amp chips. A key feature of this design was a small angle bracket by which the large earth track in the middle of the p.c.b. was bolted firmly to a thick chassis plate.

A recent new batch of circuit boards came with solder resist, even though we had not specified this. It made soldering some components a little more difficult, due to the small solderable area, but we got used to it and carried on as normal.

However, we began having a hum problem, and this was variable, better on some amplifiers and worse on others. At first, I put this down to variations in the finished equipment, such as on which panel the mixer board was mounted.

Then it occurred to me that the solder resist was preventing the angle bracket from making good contact and providing a secure earth bond. Solution? A scrape and solder job, so that the bracket was soldered securely to the earth track of the pcb. Result? A good night's sleep since now I have no mains hum to worry about.

The lesson? An apparently small change, such as solder resist in the wrong place, is enough to cause EMI problems. And in case you're thinking mains hum is not an EMC issue, in this case it is because it is unwanted electrical interference on an otherwise high quality audio product.

(And I have modified the p.c.b. artwork so that solder resist would no longer be a problem.)

(Kindly sent in by Robert Higginson, of AREAC, manufacturers and installers of audio induction loop systems, on 17th February 2010. Robert has been contributing interesting anecdotes on EMI to Banana Skins for some years.)

584) Unreal-wheel deal

Do all those rules for signal propagation, high-speed-digital design, and line terminations really apply to cables more than a mile long? Tough lessons you learn in a real-life application prove that they actually do.

A while ago, I got involved with troubleshooting a field issue on one of our wheel-sensing products. The product used inductive methods to sense the presence or absence of a train wheel. The inductive sensor would then drive an analog signal over twisted-pair copper wires from the sensing point to a central-processing location. The issue in this application was that the sensors were detecting phantom wheels.

The system includes some heavy hardware and software filtering, such that any noise that could affect the system would have to be in-band with the wheel-detection signal, which was approximately 50 kHz. It is well-known that electric-train propulsion systems emit a broad band of harmonic frequencies. Was it possible that a 50-kHz component of these harmonics was magnetically coupling into our cables between the wheel sensors and the central-processing system? Our first reaction was that this scenario was not possible because we always used shielded cables and grounded the cable shield at the receiving end of the signal.

After weeks of frustration, I came across an old textbook stating that, when the cable length exceeds one-twentieth of a wavelength, you should ground both ends of the cable shield instead of just the receiver end. Just out of curiosity, I ran the calculation for one-twentieth of a wavelength for my signal at 50 kHz and determined it was 300m. Hmmm. Our cables in some cases could be as long as 2000m. Could it be that these recommendations and formulas that I had reserved in my mind for high-speed digital design applied to a much lower-frequency analog signal with a nearly one-mile-long cable?

We modified the installations in which our cable lengths exceeded 300m to ground both ends of the cable shield, and we thus solved the problem.

(Taken from "Tales From The Cube" by Jeff Fries, GE Transportation, in EDN, September 3, 2009)

585) The dark side of the light

When a new design is exhibiting strange timing bugs, it can be difficult to decide where to begin your debugging. So, set it up on a testbench, hook it up to an oscilloscope, turn on a desk lamp, and get to work.

The morning after my technician had prepared the board for its date with the oscilloscope, we started to talk about the debugging plan. He told me that he thought he had identified the source of the problem. "It's the lamp we're using on the lab bench," he said. "The light is giving off noise and messing up your software." I was excited to learn he had a theory, but its unlikelihood immediately let me down.

"It's not the light. How could the light be causing the software to get confused?" I said, somewhat scornfully. I turned on the light and shined it at the board, and the LED pattern immediately changed from normal to anomalous. I was stunned. I put a piece of paper between the light and the board, cycled power on the board, and watched the LED blink happily. I removed the paper, and the LED pattern went bad again.

By cutting a hole in the paper about the size of an IC, I was able to selectively direct the light onto each component on the board and soon identified the problem: Light shining on a Bluetooth-interface IC caused the corruption. The Bluetooth chip was connected to the SPI bus for programming, although the connection was unnecessary because the chip's default settings worked fine. I solved the problem by cutting the SPI lead connections to the Bluetooth part, and the controller buzzed along peachily ever after.

(Taken from "Tales From The Cube" by Edward Sullivan of Fibertek Inc., in EDN, August 6, 2009)

586) "Dog" PLL chases its own tail

What to do when an LC oscillator insists on wild phase gyrations around a desired phase-lock point? One engineer is able to tame the beast.

Long ago, I was developing experimental LAN-interface hardware to transmit data on a synchronous-RF carrier from a master unit to remote devices that simultaneously returned data on a synchronous-RF carrier two octaves lower. I amplified the received carriers to TTL (transistor-transistor-logic) levels for digital-PLL (phase-lock-loop) CDR (clock and data recovery).

One of the biggest problems was getting the master unit's receiver PLL to recover the returned carrier without jittering all over the place when the loop-filter bandwidth was small. No matter what I tried, the LC (inductor/capacitor) oscillator on the wire-wrapped breadboard simply would not run in a stable fashion at a narrow loop bandwidth. It insisted on wild phase gyrations around the phase-lock point.

I suspected that synchronous digital noise from both the local transmitting oscillator and returned carrier was pulling the PLL oscillator. I verified this suspicion by disconnecting the PLL-control voltage from the oscillator varactor, leaving only the assumed stray noise coupling. Sure enough, when I manually tuned the oscillator close to the operating frequency, the device locked strongly and stably to the digital noise without jitter.

Rebuilding the LC oscillator in a metal box to fully shield it from digital electromagnetic fields and filtering the power-supply- and control-voltage inputs resulted in an amazing improvement. I learned that you must protect PLL oscillators from digital-synchronous-noise influences from supply rails and stray electromagnetic coupling.

About a year later, I was developing hardware that exchanged data between a remote slave and a master unit using two optical fibers. I had designed my receiver's clock recovery for both the slave and the master to rely on well-behaved LC tanks rather than ornery PLLs. A colleague, on the other hand, had designed the master unit's optical-link clock generator to use a PLL digital IC with an RC (resistor/capacitor) oscillator. The master clock rate was 16.384 MHz, but the optical links required 19.456 MHz for pattern-synchronization overhead, and the budget did not allow for a more stable VCXO (voltage-controlled-crystal oscillator).

The optical link's transmitter PLL insisted on doing those wild phase gyrations. "Impossible," I thought. All noise transients from digital transitions occur just after the master oscillator's switching transition, so, in theory, it should not be susceptible to its own noise, but it was. Disabling the master's remote-unit receiver allowed the PLL to run stably and verified the cause of the problem: Its own stray digital noise was returning to haunt it through the long path to the remote unit and back again. This round-trip delay was unpredictable; every 10m of cable length was equivalent to a 360° shift in returned noise relative to the clock period. Because the oscillator was divided by 19, phase detection occurred only once every 19 clock cycles. In the intervening cycles, the oscillator was free to become a happy wanderer. With the remote unit 1 km away, the oscillator was tracking the influence of its phase from 10 µsec and 200 clock periods earlier. This PLL was chasing its own tail.

We tamed the problem by building the VCO on a small PCB (printed-circuit board) with an unbroken bottom ground plane supported on a standoff above the main PCB. The oscillator's PCB ground plane helped to shield the topside circuit from the evil digital influences below.

(Taken from "Tales From The Cube" by Glen Chenier of Teeter Totter Tree Stuff, EDN, July 23, 2009)

587) EMI catches people out all the time

With slightly less profile, but doing no less good work, is design consultancy Plextek. According to managing director Colin Smithers: “The UK has a culture of design. It’s strong as strong – perhaps stronger – than other places and this flows from the strong base that has been developed over the last three or four decades.”

The problem with which Smithers wrestles is experience. “It has always been a problem getting people and it’s harder getting harder. We are having to ‘home grow’ more than ever because we need skills that aren’t endowed when people leave university.”

He says that, while components change and things get smaller, the same problems remain; and top of the list, in his view, is EMC. “It catches people out all the time in communications product design. The digital parts interfere with the analogue side and engineers always find that out later in the day. It’s been true for the 25 years I’ve been in the business.”

Experience is, therefore, a valuable asset. “A young engineer who hasn’t burned his fingers will use the ‘latest and greatest’ chip and the project will be late because the design is harder than anticipated, the tools aren’t right and you can’t buy the chips.

It’s like buying a kitchen,” he contended. “You never get that right first time either!”

(Taken from “ ‘Can do’ culture”, by Graham Pitcher, New Electronics 28 July 2009, pages 14- .15, www.newelectronics .co.uk)

588) But what does an EMC engineer do?

Just last week while I was talking to my mom on the telephone, it occurred to me that she doesn’t really understand what I do for a living. She knows that I call myself an EMC engineer, but what is that? An EMC engineer is not like a dentist or a high school teacher. EMC engineers do not advertise in the yellow pages and they don’t appear in movies or on television. How do I convey to my mom the importance of my profession? How do I make her aware of the exciting challenges that EMC engineers face?

I told my mom that I spent most of last week modifying the design of a data communications board to reduce radiated emissions by 20 dB. She said, “That’s nice.” (I could have said 200 dB and gotten the same reaction.) I told her the original design stopped working when it detected small glitches in the input signal, but the modified design was immune to thousand-volt transients. She said, “Hmmm.”

What I need are some examples of common EMC problems that my family can relate to. After all, EMC is more than meeting specs. EMC engineers make things work in the real world. Unfortunately, coming up with examples of everyday EMC problems that my mom can recognize is not easy. She doesn’t own a computer and doesn’t live near any radio towers.

Several days ago, I called to ask if she ever saw “snow” on the TV when she vacuumed. It was difficult to communicate with her because we both could hear another telephone conversation on the line, apparently in Chinese. She thought I was asking about the weather. She told me they hadn’t had any snow for two weeks and that she didn’t watch TV when she vacuumed. So much for that idea. Somehow, somewhere there must be an EMC problem to which my mom can relate.

I heard there was going to be a network-news special on EMC so I called my mom and told her to watch it. This seemed like the perfect opportunity to show her what I do for a living. TV news programs can make any topic seem exciting and important. I couldn’t wait to see what they had to say about EMC. Since I was going to be out of town, I arranged to record the show. Unfortunately, a power flicker reset the programming on my VCR, so I missed it. My mother also missed it because the neighbor’s new computer was causing the sound on her TV to fade in and out. Normally, when this happens she drives over to my Aunt Helene’s house to watch TV. But her new car hasn’t been running properly ever since she had the wireless security system installed. Not that it would have made a difference. Just as the program was starting, a low-flying plane triggered her automatic garage door opener, allowing the dog to escape.

(She's had to keep the dog in the garage ever since lightning took out her electronic fence.) Another opportunity missed.

I guess I'll just have to live with the fact that some people never encounter EMC problems and that my mom may never fully appreciate what I do for a living. Oh well, at least I can feel good knowing that I am in a profession that is exciting, challenging and important. I may not be able to discuss it with my mom, but there are plenty of professional EMC engineers at chapter meetings and symposia that really enjoy talking about EMI, ESD, transients and similar topics. And as a profession, we must be doing a pretty good job. Otherwise, there would be a lot more EMC problems plaguing the typical, everyday user of consumer electronic products – like my mom.

(EMC Society History – EMC Society Newsletter, Spring 2009, by Daniel D Hoolihan, repeating an article originally provided by Todd Hubing as "Chapter Chatter" in Issue No. 164, Winter 1995, www.emcs.org/acstrial/newsletters/spring09/societyhistory.html)

589) EMC War Stories from Samuel Burruano

The technical stuff is great, but there are a lot of stories to show you that EMC can be a fun job.

My first experience with the Air Force One (the US President's plane) was in 1959. Eisenhower was President and Nixon was on his way to the Soviet Union for discussions (the famous July 1959 "Kitchen Debate" between Nixon and Khrushchev took place at this meeting). As the plane was flying over Poland, their navigation system, which used triangulation, was being jammed by some interference sources.

They couldn't hear any of the transmissions from the radio stations and so they needed navigational help to get into Russia. When Air Force One came back from the Soviet Union, I was working at a division at Filtron and they called. Sam Skolnick showed up at Filtron in New York and said, "We want to borrow Sam Burruano for three nights." They apparently thought it was going to take that long to find out what the problem was. My management agreed and I went over to look at the problem. They must have had about 15 or 20 guys out there making microscopic measurements on the body of the airplane.

So I went up to the Colonel who was running the thing and said, "Look, send these guys home, I'll solve the problem for you." (You pray a lot when you do this, because it's gutsy. But I'm a Sicilian and that makes a difference.) He took my advice and sent the other guys home; then, I sat down and started to ask the logical questions. What could be causing this? (It was evident that it had to be on the airplane.) What could it be? Could it be a broadband source or a continuous wave source… or could it be the electronic system or the electrical system?

The Colonel said, "What do we do?" I suggested we list all the electric systems. He agreed, so, I made the list of all the electrical systems and the electronics systems. In order to eliminate the electronics systems, I turned all of those on at once and it didn't do a thing to the navigational system. So, then I started to go through the electrical systems one by one. All of a sudden, BZZZZ!! Boy I found it! I looked down to see what it was and it was the fluorescent lights. So, it was a very simple solution. I got some special lamps and applied one filter and the interference was gone. They thought I was a hero. (I know, a hero is really an Italian sandwich!) Thereafter, the Air Force One people took me on as their guru.

It turns out, there were other problems. Dean Rusk was in an Air Force One coming back from one of the European countries. They were trying to land at an airport in Paris and they couldn't land. There was a broadband "noise" on the aircraft that was jamming everything up through the UHF band. They couldn't communicate; they couldn't land the plane and they flew around for about three hours until the thing "cleaned up" by itself.

When they landed in the USA, they obviously wanted it fixed! They called me up from the White House and asked, "Could you come down here because Johnson and Kennedy want to go to an Air Force base for some sort of thing they have to attend. I drove from Boston to Andrews Air Force Base from four o'clock in the afternoon to twelve o'clock noon the next day (through a thick fog) to get there. So, I get there and the contact person said, "Well, what do you want to

do?" I said, "I need a couple of pieces of equipment." I got them and then I said, "Take me up to forty-thousand feet."

We get up to forty-thousand feet and, sure enough, the systems "jammed" after just a little while at the outside ambient temperature of -50 degrees Fahrenheit. So, we came down and we couldn't land the airplane. So, what the pilot thought he would do while the plane wasn't responding was that he would do touch-and-go (the plane lands briefly and then takes off again immediately). Unfortunately, that maneuver made me air sick! Anyway, we eventually landed and started to look for the problem.

We began by taking everything apart since we really didn't know what to do. I was taking connectors apart and we actually took a wing apart because we thought maybe it was the grounding system affecting something that we needed to know about. (They had lousy grounding systems in the Boeing 707's in those days.). If you can imagine it, they had everything going to a single-point ground somewhere down "the lower 41" as I used to call it. That was the worst thing they could have done.

We struggled for three days trying to solve the problem. Finally, on the third day, I said, "Look, what did you put on this plane that was new in the last three years?" One guy said, "Gee whiz, the only thing we did was put a blanket on the antenna cover for the HF system!" So, we looked at that. We turned everything on and we went up and looked at this cover, and sure enough, there was a thermostat on the cover going [up and down]. The transients from that thing – the broadband energy (the Fourier products) – were extended even beyond the UHF band. We put a new thermostat on the cover and the interference was gone!

There's one more story that I should tell. I was a radar designer, and I was in between jobs and I had just finished working on a spherical-radar. I had done the synchronizers, the video stuff, the indicators, the display system, and the power supplies. (I did a lot of work for a twenty-five-year-old guy just back from the service.) RCA had bought out an outfit in California which made a very-small, but actually a beautiful radar, called the X-42.

General Lemay tried to land his plane at Wright-Patterson Air Base and he couldn't, because, with the radar on, it jammed everything on the aircraft. So, he turned it off in order to land and when he came down, he said to "to get that out of there." He then shut down the plant that made it. I was in between jobs at RCA so they said, "You go fix it." I went to the Navy Development Center to work on it and it was a mess.

If you initialized the radar, it had a little DC motor that generated so much noise that it just wiped out the display completely; it was just one big white [noise] thing. There were more problems with that than you can imagine. But, over a period of time, I fixed it.

(Taken from "EMC War Stories: A Collection of Tales", by Samuel Burruano, Founder of the IEEE EMC Society, IEEE EMC Society Newsletter, Issue No. 221, Spring 2009, www.emcs.org/acstrial/newsletters/spring09/WarStories.html)

590) The real costs of static electricity (1 of 2)

On average, says the ESD association, stray electrostatic discharges destroy about 16 to 22 percent of electronic components before they are installed into an assembly. After assembly, anywhere from 33 to 70 percent of digital devices fail soon after customers purchase them because ESD may only damage a component, enabling it to function for a brief time before failure.

The costs of these losses can reach into billions of dollars annually. Not only does the cost include the loss of the damaged product, it also includes all the repair, rework, shipping, labor, and overhead costs associated with the damage. As engineers at companies like IBM, Jabil, Flextronics, Selectron and Sanmina-SCI develop electronic chips and components that can be destroyed by as few as 5 volts, the costs could reach even higher.

Most contract manufacturing facilities can control static electric discharges as low as 100V. As mentioned earlier, however, that level will not be sufficient for components sensitive to 50 or even 5 volts. Increasingly, these facilities will need to prove that they have eliminated all potential opportunity for electrostatic discharge.

(Taken from: "ESD Fundamentals – 10 Common Myths about Static Electricity", by Don Schutz, Conformity, 2009 Annual Guide, page 161, www.conformity.com.)

591) The real costs of static electricity (2 of 2)

According to the ESD Association, ESD losses can be as high as 10% of annual revenues, with an estimated average negative impact of 6.5% of revenues. Based on 1997-2001 production data, the international electronics industry is losing in excess of $84 billion every year. To prevent this damage, the industry spends more than US $8 billion each year.

(Taken from: "How much do your ESD solutions really cost?", by Rodrigo Lima, Ciba Corporation, Conformity, March 2009, Page 36, www.conformity.com)

592) Robot scanner checks chip fields

In a collaborative project carried out with Continental and Infineon Technologies for the Electronic Nanosystems (ENAS) has developed a measuring system that can locate weak electrical and magnetic fields to an accuracy of a few hundredths of a millimetre.

"Circuits are becoming more and more susceptible with each generation," claimed Thomas Mager of the Fraunhofer ENAS in Paderborn. "Only a few years ago, it still took several volts to destabalise processors. Today, a few hundred millivolts are sometimes enough to disrupt millions of transistors."

Mager argues that designers of electronic circuits need to give greater consideration to electro-magnetic compatibility. It is no longer just a question of protecting electronic packages such as cell phones or MP3 players against external influences, or shielding the environment against their electromagnetic emissions, but is also about how each individual component on the circuit board behaves.

The near-field scanner is a robot fitted with a probe that moves across the surface of a circuit board. Different probes look for electric and magnetic emissions from the circuit. An inductive-loop probe measures the magnetic field and small electric dipoles or monopoles detect the electric field components. Software then reconstructs the electromagnetic field from the measurements.

(Taken from: "Robot scanner checks chip fields", IET Engineering & Technology magazine, 25 April – 8 May 2009, page 6, www.theiet.org/magazine)

593) Electric razors used as anti-missile devices

An interesting story in the Newsletter [of 50 years ago] centered on a unique Anti-Missile device. In a book about World War II, titled 'Walker R.N.' and published by Pan Books Ltd., London, on page 135 is the following, "Against the 'Chase-me-Charlie' there was no defense until, one day in the bay, an escort was attacked by an aircraft which launched its 'glider bomb' just as a scientist aboard switched on his electric razor to test out a theory.

To the amazement of the ship and the enemy aircraft, the new weapon gyrated about the sky in a fantastic exhibition of aerobatics, finally giving chase to its own 'parent.' In some inexplicable way, the 'Chase-me-Charlie' control system had been affected by the electric waves given off by the razor.

This method was never officially admitted by the Admiralty as a defense measure, but the ships which sailed into the 'Chase-me-Charlie' areas found it fool-proof. In Liverpool, there was a sudden run on shops selling all makes of electric razors."

(Taken from: "EMC Society Newsletter Review – 50, 25 and 10 Years Ago" in the EMC Society History section, by Daniel D Hoolihan, the IEEE EMC Society Newsletter, Issue 220, Winter 2009, http://www.emcs.org/acstrial/newsletters/winter09/history.pdf)

594) "Ex-capacitors"– X caps that rapidly lose their value

I'm working in a small company in the lighting business. In your article about the 'sticking pedals' there is a phrase that made me write to you. It says: "Although electronic components must pass a set of EMC tests to (help) ensure safe operations, the evolution of EMC over time is not characterized and cannot be accurately forecast." (A quote from Alexandre Boyer *et al*:

"Characterization of the Evolution of IC Emissions After Accelerated Aging", IEEE Transactions on EMC, Vol. 51, No. 4, November 2009, pages 892-900.)

I believe that this topic is completely ignored by engineers in the lighting business, and probably elsewhere too. The following is my recent experience in this area.

After buying a new EMC test appliance (PMM9010), I had to get used to the new software. I therefore took one of our electronic ballasts for fluorescent lamps, which had already been in use for about three years in permanent mode (24/7). I started measuring the conducted emissions. The result was shocking: the lamp was far beyond the limits according IEC 55015.

I couldn't believe it. During development, that product has been tested thoroughly by myself and been found compliant to the standard mentioned above.

Next I took a new ballast from our shelf and it was found compliant. After searching I found that the X2 capacitors (a commonly-used type from a well-known European manufacturer) had lost more than 90% of their value. Instead of 100nF they were down at less than 10nF! That was the reason for being out of compliance.

I contacted the manufacturer immediately. Their answer was: "You are describing here a well-known problem on X2 capacitors (across the line) X2 capacitors are safety capacitors designed to fulfil the IEC60384-14, UL specs, CSA specs.... Means the cap is allowed to do everything, but not to fail in an unsafe way! This has to be guaranteed and will be checked according to the requirements of the IEC."

"To be here on the safe side such caps will be produced in a special way with special design and process parameters. Disadvantage is here that such caps are not really stable concerning capacitance! The capacitors are designed to fulfil in minimum the requirements of the IEC which say, that such a cap is allowed to lose max 10% of its capacitance during 1000h of operation."

"Reason for this capacitance decrease is ionization, a partly discharge of the capacitors over the metalized surface of the film material! To avoid this problem it would be necessary to use a capacitor with internal series connection. Here we have a special design with internal series connection. This series connection within the cap divides also the voltage at the caps by 2, so ionization is not possible."

I noted that over the period of 3 years that the tested ballasts had been in permanent use, a loss of capacitance of 10% per 1000 hours would result in a capacitance reduction from 100nF to 9nF, and I measured less than 10nF. So the -10% per 1000 hours can really happen, it is not merely a limit in IEC60384-14!

Next I checked our competitors' products. Like us, they all use also the smallest model of X-capacitor available – the type most likely to suffer capacitance loss at 10% per 1000 hours. That means that most electronic ballasts for fluorescent lamps will lose their EMC compliance after quite a short time. I believe that most engineers are not aware of this.

I also got an e-mail from the product manager saying that: '... although that phenomenon is well known, that capacitor technology continues to be used as state of the art...' (Translated from German: '... obwohl dieses Phänomen allgemein bekannt ist, wird diese Technologie ohne grosse Bedenken und als allgemeiner Stand der Technik eingesetzt...')

After realising that we had a major problem, I contacted the Director Application Engineering Europe of KEMET, who publishes good stuff on the internet. He wrote by e-mail: "The problem is that to pass the X2 certifications, certain parameters have to be optimized, but for long-life applications the best solution remains the impregnated paper. This loss of capacitance can occur, both when X2 are used across the line (parallel) or in series if used as voltage dividers (for low power applications). The life degradation can be due to air and humidity penetrating into the structure which via corona discharges can diminish the metallization which in turn results in capacitance loss. You are correct, X2 certified capacitors must be chosen with caution!"

Murata, who make ceramic X-rated capacitors told me “Over time, the capacitance of ceramic capacitor would decrease also due to the aging characteristics of MLCC though the decrease is very limited. Additionally, if AC voltage is imposed continuously, the decrease of capacitance is more limited, a few % decrease over 10 years or something.” He sent me a graph that illustrated this claim.

We have now decided to use the WIMA type MKP-X2, where an operational life of greater than 300,000 hours is specified. It's only slightly bigger than the type we were using that lost 90% of its value over 3 years. To be honest, I'm a bit wondering how they manage to manufacture this comparatively small capacitor. But they provide us with a guaranteed lifetime. As we have neither the time nor the means to test these capacitors, we have just to trust the manufacturer.

Until some months ago, X2 capacitors have not been regarded as critical components. That has completely changed... That's what I'd like to tell all R&D engineers: X2 capacitors must be chosen with caution!

(Kindly sent in by Daniel Elser, LUMATEC SA, Geneva, Switzerland, on 10th May 2010. The Editor writes: I checked whether this problem with X2 capacitors was as well-known as some capacitor manufacturers claim, with a colleague who is the compliance manager for a large manufacturer, who said: “I don't think most people are aware of this. The rule of thumb has always been to pick a voltage rating twice the level expected for the cap to see (as you mention below). I learned about this when designing PC board filtering (obviously much lower voltages than mains). To be honest, when I was specifying power supplies from 3rd parties to go into our line powered stuff, and performing the testing you mention, I wasn't thinking about this problem. I suspect this is not unusual. I would encourage anyone to take this into consideration.”)

595) EMI problems for wireless datacomms in factories

A great deal of planning is required if different wireless networks are to operate together effectively. Interoperability of wireless protocols is now becoming a real and extremely important consideration to adopters of wireless communications in factory automation.

Currently, the biggest obstacle to adopting wireless communications for machine builders and end users alike is reliability. The presence of heavy machinery that can interrupt wireless signals, together with the increasing importance of gathering dependable, detailed machine data, has convinced most, for now at least, that wired solutions are best.

However, more and more companies are now beginning to experiment with wireless products that have been specifically designed and ruggedised for use in a factory environment. They want to improve, having chosen the correct infrastructure and wireless technology, the performance functionality of their industrial networks.

(Taken from: “Embracing the wire” by Mark Watson, Components in Electronics, March 2009, www.cieonline.co.uk)

596) Car trouble

(Some correspondence from the Letters pages of the IET Engineering & Technology magazine, www.theiet.org/magazine)

Philip Quayle asks (Letters, Vol 4 # 20) what can be done to mitigate interference to his car’s security system. A portable EMI shield is the only answer, I am afraid. Remote central-locking key-fobs and immobiliser key-checking systems use one of the many industrial, scientific and medical (ISM) radio bands, which are a free-for-all so long as you keep your transmitter power below a certain limit. Vehicle remote locking and immobiliser systems tend to use the 433MHz allocation, as do wireless doorbells and numerous remote-control systems.

The same problem exists in the 2.45GHz ISM band. With Bluetooth, microwave ovens and Wi-Fi users working the same frequencies, interference and signal losses due to water absorption (there’s a reason ovens work at 2.45GHz) make a wired solution far superior.

(Gary Myers MIET, Biggleswade, Bedfordshire, 23 January – 5 February 2010 edition)

Philip Quayle has identified a problem that is destined to become much worse before it gets better. Although there is a plethora of EMC regulatory requirements, electromagnetic

compatibility between systems seems to be slipping out of control. This is in spite of the fact that vehicle manufacturers spend a great deal of time in implementing EMC control plans and a vast amount of cash in submitting their products to the ministrations of test houses.

The problem has arisen because of the inexorable increase in the complexity of electronic systems. While close control has been maintained to meet requirements such as frequency response, functional performance, power consumption, size, mass and cost, this control does not extend to EMC.

Over the years, the subject has acquired an aura of mystery, leading to the belief that only researchers who have a comprehensive grasp of the mathematics of electromagnetic field theory can hope to understand the mechanisms involved. The engineer-at-the-bench is often hamstrung by a set of design rules that were originally formulated several decades ago. If these rules are based on the concept of 'the equipotential ground plane' or on the need to 'avoid earth loops', then the EMC of the system is doomed.

(Ian Darney, Bristol, 23 January – 5 February 2010 edition)

My experience of cars fitted with full electronic engine management systems has, over the past 20 years, been entirely satisfactory with normal operation even in the presence of high-level RF fields. The microprocessor systems are screened by the surrounding body metalwork and, in some cases, by additional metal housings.

There are however clues as to the possible cause of the problem described by Mr Quayle. It would appear that initially the central-locking system operated to allow entry and then failed; the starter motor did not turn the engine, this being followed by the display of various warning lights; and, finally, the vehicle age being at least five years.

Modern car batteries are fully sealed and the cell interconnecting straps are not visible. It is quite possible, and indeed normal, for a five-year-old battery to develop an intermittent high internal resistance. Such a fault will cause the battery voltage to collapse almost totally when the demand of the starter motor is placed upon it and this could cause some of the engine management running programme to be lost. It will also give rise to the display of various warnings and cause the central locking to fail. Mechanical shock or minor thermal changes can 'cure' this.

(Geoffrey H Robinson CEng FIET, St Andrews, 23 January – 5 February 2010 edition.)

My son-in-law had been unable to start his Range Rover for two weeks and had spent many hours with an experienced auto electrician trying to trace an unusual sequence of electrical faults. The vehicle in question was parked within a few yards of its normal parking position, near to the MoD complex at Hawthorn, Corsham in Wiltshire. Recent activity has been seen close to the house where new communications cables have been laid and, of course, there is the underground MoD facility at Corsham.

On reading Philip Quayle's letter I rang my son-in-law and suggested he parked a van beside the car in question. He did this and two weeks of misery were solved at once!

(Alan Wilson CEng MIET, Corsham, Wiltshire, 23 January – 5 February 2010 edition.)

Philip Quayle's problem is well known, widely predicted and would have been avoidable if only the government department responsible at the time had listened to advice. The majority of vehicle key transponders use the allocated frequency of 433.92MHz. This is slap in the middle of a very busy segment of an internationally allocated amateur radio band. The SRD band is located right between the input and output channels (offset 1.6MHz) of a UK-wide (and, indeed, Europe-wide) network of amateur radio repeaters. Users are both mobile and fixed, including urban areas, and power levels can be legitimately higher than commercial mobile licenses permit.

However, amateurs are only one of several unwitting factors in this debacle. Drivers also experience transponder blocking problems from the government TETRA network, from long-range radar systems and probably many other UHF systems. The original presumption might have been that vehicle transponders would be designed around conventional superhet

receivers, but since this design doesn't integrate onto silicon very well, various other lower-grade receivers are now the norm, with correspondingly poor out-of-band performance.

(Bob Burbeck, MIET (G4NOB), 23 January – 5 February 2010 edition.)

The problem that Alan Wilson's son-in-law experienced starting his car (Letters Vol 5 # 1) and which was blamed on electromagnetic interference, is exactly the same as I experienced. The source of the interference was ultimately traced to an energy monitor transmitting from the coil round the incoming mains supply to the remote display. A letter to the device's manufacturer merely resulted in the reply that its equipment conformed to all relevant standards.

(RA Easthill CEng MIET, Horley, Surrey, 20 February – 5 March 2010 edition)

597) Compact Fluorescent Lamps and mains waveform distortion

Your article on the shortcomings of CFLs seems to omit one previously well-reported item: their low-operating power factor. The CFL operates at a power factor of about 0.6. This is not primarily due to the usual phase-shift effect, but is mainly a consequence of the severely distorted current waveform the CFL draws from the supply mains.

A simplified numerical analysis of the internal rectifier-inverter circuitry of the CFL shows that the supply current waveform has a fundamental (50Hz) component with a power factor of about 0.9 leading and a total harmonic distortion of about 115 per cent.

A few years ago, there was a considerable outcry against the harmonic current loading of most electronic equipment, and its potential for disturbance to the supply network. This outcry seems to have died away recently. There has been some reporting on a high power factor CFL, but this does not appear to be available on the retail consumer market. Possibly the needed changes would result in making the CFL unaffordable.

It is to be hoped that the upcoming LED-based replacement for the CFL will not have the same waveform distortion problems.

(Tony Fisher MIET, IET Engineering & Technology magazine, Letters p17, Jan 2010, ww.theiet.org/magazine)

598) Defence EMC requirements get tougher

If ancient armies marched on their stomachs, today's defence forces gain their superiority from an intensive diet of electronic intelligence. With large quantities of electronic equipment operating within a relatively small space, assurances on Electromagnetic Compatibility (EMC) have assumed greater importance.

Moreover, as an army's opponents become more adept at intercepting information, and new types of intelligent weaponry such as situational awareness systems are able to identify targets by their electromagnetic footprint, government agencies and other specifiers are setting increasingly stringent EMC standards. In fact, these criteria often make up the most rigorous aspect of the design and development specification for new military equipment.

In addition, as equipment such as communications and radar devices, and their sub-systems including switch-mode power supplies, evolve to operate at higher frequencies, EMC protection measures must also improve to be effective at the higher frequencies. This can require significant changes in the techniques employed.

Experienced defence contractors are now dealing with demands to take EMC protection in new systems to an unprecedented level. A recent project by Tekdata Interconnections, to develop wiring harnesses for communication equipment used in homeland security applications, specified EMC criteria that are more severe than any applied in previous projects. The team was able to satisfy the requirements using proprietary best-practice techniques; however, improved design techniques are now being developed in anticipation of further increases in EMC specifications.

(Taken from: "Raising the bar again", by Mark Howitt, Components in Electronics, February 2010, page 25, www.cieonline.co.uk)

599) Electric vehicle causes EMI

A super-fast sports car remodelled as an electric vehicle will soon take to the world's longest road.

However, technical problems are as much a concern on the route as finding charging points for the vehicle. The first of these was seen during the car's initial drive when problems with electromagnetic interference (EMI) meant that it had to go back to the garage for several days.

"There was actually a moment where we charged the car up in a private house and suddenly phones start ringing, bells start ringing, and we were like what is going on?" said Clemens Lorf, chief operations manager. We realised it was because of EMI and this is not an issue just for us; the industry is still working on a standard on EMI and we're figuring out what everyone else is trying to understand out there at the moment."

EMI is one of the biggest problems for electric and hybrid vehicles. Each of the main components of the SRZero's electric drive act as a path for electromagnetic emissions, with the power converter being the main source of EMI. High levels of EMI can lead to mixed signals being sent to other components in and around the vehicle, causing the electrical systems to behave erratically.

After the initial setback, the team solved the EMI problem by using a combination of shielded cable, a range of capacitors and some ferromagnetic ceramic rings to reduce the SRZero's noise levels from EMI to acceptable levels. A week later, the group took the car on the M25 and set a record in becoming the first team to drive an EV around the London orbital twice on one battery charge.

(Taken from "Eco trip", by Ellie Zolfagharifard, The Engineer, 14 June 2010, pages 24-25)

600) The Egg McMuffin pay rise

When McDonald's restaurants introduced their new Egg McMuffin dish, they supplied all of their hundreds of thousands of restaurants worldwide with the new machine designed for cooking it.

After a while, they noticed something odd – all their morning staff were booking more hours, and consequently being paid more. But the other shifts did not change their working patterns.

They eventually found that the Egg McMuffin machine was putting so much noise onto its mains supply, that the time clocks used for stamping employees timecards – which ran from the same electricity supply - were running faster. So although the morning employees clocked in and out at the normal times by their wristwatches, the time card clock thought they had been there for longer, so they got paid for more hours than they had worked.

When a fix for the mains noise emissions was decided upon, every one of the Egg McMuffin machines in their stores worldwide had to be modified accordingly.

Apparently, this is the reason why McDonald's in-house EMC standards, used for purchasing equipment for their restaurants, is said to be "tougher than MIL-specs".

(Kindly provided by Stephen Buol, a Principal Electrical Engineer with Rockwell Collins in Cedar Rapids, USA, on May 24th, 2010.)

601) 19th Century EMI

REF^{CE} N^{o} SB/318 Bristol Docks Committee, Traffic Manager's Office, Bristol, Feb 28th 1887

To B Girdlestone Esquire, Secretary and General Manager

Dear Sir Avonmouth & Portishead Telephones

I beg to report that these telephones are still working most unsatisfactorily.

The private wires from this office to Avonmouth & Portishead are either in contact with other wires, or the induction is so strong as to render the use of the telephones at times impossible. The fault or faults have been reported to the Telephone Co. Several times, with Urgent requests for the lines to be put right at once, but so far from there being any improvement I believe the telephones are daily becoming more defective generally. We are in consequence greatly inconvenienced here, and our people at Avonmouth & Portishead are continually

complaining of the imperfect working of our telephone system, and the delay to business occasioned thereby us becoming serious.

Will you please to take up this matter very strongly with the Telephone Company and oblige.

Yours respectfully, J M Macnab, Traffic Manager.

(Kindly sent in by Steve Bilney, EMC Engineering, MBDA Filton, 5th August 2010)

602) EMI-induced errors in machine's databus systems

Bus systems have become an integral part of machines and industrial plant. However, data transmission can be impaired by electromagnetic interference - electromagnetic (in)compatibility. The close proximity of power electronics and data lines may cause problems which can result in data errors... Electrical engineers will probably know something about the statistics of data corruption while most mechanical engineers will associate EMC with intractable and idiopathic problems. EPSG has carried out analytical test work which sheds interesting light on EMC-induced errors. Specifically the results of new work suggest that the method of network data framing has a significant effect on error rate.

Modern machines include numerous electronic power components for the running and control of drives and servo motors, in particular frequency inverter and servo inverter systems. Such devices inherently produce voltage gradients which are a product of both the (high) voltage being switched, the switched current and the inverse of the switching time (rise time). One could also add to this mix the ever higher switching frequencies employed in the search for conversion efficiency. Taken altogether inverters can be an incredibly powerful and pervasive source of broadband electromagnetic interference. But of course in any industrial plant, there will be other potential interference sources as well.

Let us look at a typical situation: an error diagnosis system reports a controller failure, but subsequent analysis shows the suspected components to be functioning properly. It takes much time and effort to find out that the malfunction is not caused by defective parts but by electromagnetic interference. Modern diagnosis systems can locate errors more or less precisely. Practical though this is, it only hints at the location of the error, not its cause.

Maintenance experts can take their pick from a whole bunch of possible explanations: initially, it is not obvious whether they face software problems, defective hardware, bad wiring, bus faults, possibly even a rare memory error caused by cosmic radiation, or whether the cause lies in electromagnetic incompatibility of the components. Tracking down the source of the interference or the segment with insufficient shielding resembles the proverbial hunt for a needle in a haystack.

However robust they are, all machines are subject to wear, and the more they wear out, the greater becomes their susceptibility to interference. Continual (electrical and mechanical) shocks strain the contacts while and insulation (and electrical screening) of moving parts such as drag chains suffer during sustained operation. Since wear unavoidably increases vulnerability to interference, all potential weak points must be avoided in the design phase. Unsafe machines can hardly be made safe afterwards. EMC strategies need to be observed from the outset.

(Taken from: "EMC and errors: searching for a quiet life in the control cabinet", The Industrial Ethernet Book, April 2010, Pages 22-23)

603) EMI and RFID down on the farm

At long last a banana skin of my very own! I was lately called to a dairy farm as they were experiencing difficulties with their RFID equipment detecting the presence of the cows in the milking parlour, although when first installed the equipment had worked perfectly.

I drove out to the farm on a dank morning and having driven the last 100 yards over a sea of cow pats I reached a spotless cow corral and parlour.

It had just been automatically scraped and washed and effluent gathered into a slurry pit. This was an impressive set-up as several hundred cows had to be milked twice daily. The cows were funnelled through a plate antenna to their milking cubicle. All the human had to do was

clean the teats and attach the suckers. As the cows went through the plates the tag on the cow's ear was charged up and then the RFID chip radiated the cow's details. When a cow was installed in the cubicle (one of 50 such) the cubicle rotated to present the next cubicle for the next cow. The cow would be milked before the 360 degrees were completed and the suckers removed so that the cubicle was vacated for the next animal. The milk from the cow was cooled and measured and pumped to a central location for collection by the creamery whilst the statistics on the cow were gathered. All very automated and efficient.

After 3 months of operation however, suddenly the cows had to be within 10cm of the antenna before it would detect them. The RFID frequency of operation was relatively low and a check revealed that RFID signal was every bit as strong as the specification detailed. However what was noticed was that the background signal level at that frequency was particularly high. Time to switch off everything and see what the actual background signal level was.

When this was discovered to be normal, one pump at a time was switched on (out of a total of 7). The first pump did not add to the background signal level, but the second did, as did all the others. Investigation showed that the first pump was a later version than the others and had its EMC filter built in. The others all had an external filter as recommended by the supplier. Spare filters were on hand and when one was replaced (at 100euro) the background signal level was seriously reduced.

Replacing all filters brought the system back to its original condition and cows could be easily detected again.

Job nearly done except to decide what could have damaged all the filters? Something inborne on the mains supply was the obvious culprit. The farmer was proudly showing me the rest of the system including the new 300kW standby generator recently installed when warning bells rang in my mind and sure enough the trouble would seem to only have started after the generator was installed and tested.

How easily can new improvements interfere with an existing set-up! It all seems a long way from when Daisy or Buttercup was greeted personally by the farmer each day.

(Kindly sent in on the 26th August 2010 by Tom O'Brien B.E., ElectroMagnetic Technologies Ltd., Inniscarra, Cork, Ireland, www.emtcork.biz. Fame at last, even if it is only Banana Skin fame.)

604) Robots that move on their own

Well between us we certainly managed to do something, the company made robots that would intermittently move on their own, and I was given to believe this had been a problem for many years. Your visit helped to persuade them to part with serious money. They bought a piece of EMC test equipment and discovered it was spikes coming down the mains that set things off. The whole diagnostic process only took about 2 hours!

(Extract from a private email in November 2010, from P.R. of PS Envisage Ltd, ps.envisage@btinternet.com)

605) RF modulation blows up power supply

I can positively state that in rare occasions equipment can be susceptible to different modulations.

I have experienced this (in a BIG way) when a three-phase power supply failed during EMC testing when the modulation was changed from 1kHz to 2.2kHz.

The power supply, which was part of a system of equipment, failed resulting in a dead short across the supply. Some of the interior components vaporised (wire wound resistor – the wire vanished) and the aluminium cladding had a large "lump" missing.

The cause was the RF getting into the power supply where it was demodulated (AM modulation) – it was the 2.2kHz that actually caused the problem in the control circuit, switching on all the HEXFET's at the same time and producing the short across three phases.

(Kindly sent in by "Anonymous" in October 2010. Apparently the power supply had no internal fuses and he (or she!) forgot to add external fuses when testing, resulting in a more spectacular

bang than would otherwise have been the case. Hence the desire to remain anonymous. As we all know, these sorts of oversights are great teachers – providing we survive them.)

606) Deaths caused by EMI with some early electronic ABS systems

Years ago, while employed by Centralab, I did a study and design work for X (a large and well-known automotive manufacturer) on their first anti-skid braking systems. These were installed in big trucks and there were a number of accidents (some fatal).

Turned out, that police radio (in particular California Highway Patrol) transmitters were the culprit. Actually, the real culprit was lack of filtering in the X braking system electronics package which we corrected.

(Kindly sent in, on 29th October 2010, by Professor Robert Stevenson, PE, Senior Scientist, Greatbatch Medical, Inc., Santa Clarita, California. Bob was Chief EMI filter engineer at Centralab at the time of the events reported above.)

607) Britain vulnerable to space nuclear attack or 'solar flare' storm

Dr Fox highlighted warnings from scientists that essential infrastructure such as satellites, could be paralysed by a once-in-a-century solar flare. Rogue states such as North Korea and Iran could use nuclear weapons to attack Britain's vital communications and electricity networks from space, a security conference heard.

In a stark warning, Dr Liam Fox warned countries that sought nuclear capabilities could attack Britain from the upper atmosphere instead of through more traditional "nuclear strikes". The Defence Secretary disclosed that British officials believe such an attack involving a nuclear detonation would destroy vital electronic systems by producing an electromagnetic pulse.

Dr Fox also told the international conference on the vulnerability of electricity grids around the world to natural disaster and hostile attack, that an impending "solar flare" space storm could produce just as much damage to communication networks. He highlighted warnings from scientists that essential infrastructure could be paralysed by a once-in-a-century solar flare.

But Dr Fox warned that terrorists might seek to employ such methods. He urged the public to take greater heed of the threat. "I think it's a subject that we need to give a good deal more attention to, not least because we are in an era where there are those who seem to believe that we can choose to enter or not enter certain conflicts, and also because we live in a world where proliferation is becoming more not less the case," he said.

"And when we are discussing North Korea or Iran, for example, people need to understand there are other risks than just what we would consider the sort of nuclear strike we saw in Nagasaki or Hiroshima. The range of risks out there are many fold and I think we need to make that extremely apparent to the public."

Dr Fox's comments on Monday came at the summit of scientists and security advisers who believe the infrastructure that underpins modern life in Western economies is potentially vulnerable to electromagnetic disruption.

The Daily Telegraph disclosed on Saturday that that one "nightmare scenario" being privately discussed by senior defence figures involves Iran successfully detonating a nuclear device high over Europe.

The Coalition's Strategic Defence and Security Review is considering potential weaknesses in Britain's defences against hi-tech attack or disruption. Conventional military units, cyberwarfare and other technology-driven capabilities are likely to get more money when the review is concluded.

Much of the Ministry of Defence's planning focuses on the risk of a hostile state exploding a nuclear weapon in space, creating a sudden, intense burst of electromagnetic energy called a high altitude electromagnetic pulse, Dr Fox said. But planning was also for the "solar flare" storm that scientists, including those from Nasa, believe could hit the Earth within a few years.

The Daily Telegraph disclosed earlier this year that Nasa scientists believe Britain could face widespread power blackouts and be left without critical communication signals for long periods of time, after the earth is hit by a once-in-a-generation "space storm".

Dr Fox insisted the threat of such a nuclear attack was “low”, but that the Government was working internationally with telecoms, energy and transport companies to increase resilience. “With reliance, for instance on technology, comes vulnerability, and vulnerability can invite attack,” he said. “Our wider reliance on digital technologies will not have gone unnoticed among those who would mean us harm.” “We will need to ensure that those same technological innovations that provide advantage do not become our Achilles' heel.”

The Westminster meeting was jointly hosted by the Electric Infrastructure Security Council (http://www.empcoalition.org/) and the Henry Jackson Society, a think-tank.

(From an article by Andrew Hough in the Daily Telegraph, 20 September 2010, http://www.telegraph.co.uk/science/space/8014444/Britain-vulnerable-to-space-nuclear-attack-or-solar-flare-storm-conference-told.html. First mentioned in Interference Technology, http://www.interferencetechnology.com/lead-news/article/british-defense-chief-warns-of-emp-threat.html)

608) U.S. Joint Force Survivability Hinges On New Jammer

The universe is shaped by a handful of fundamental forces such as gravity and the "strong force" that binds atoms. Only one of these forces has proven to be highly malleable in the hands of human beings: electromagnetism. The skillful application of electromagnetism to every facet of human activity has made it the motive force of modern civilization. Electricity and electronics are ubiquitous in commerce and culture, and they have come to define the way we wage war. Success in combat today is largely about exploiting the electromagnetic spectrum while denying its use to adversaries. Unfortunately, some of our tools for doing so have grown obsolete at a time when enemies have more warfighting options than ever before thanks to the information revolution.

A case in point is the main airborne jamming system currently used by the joint force. It was conceived in the 1960s and fielded in the 1970s to counter hostile radars and communications systems, but technology has come a long way since then. Vacuum tubes have given way to integrated circuits, mechanically-steered radars have been replaced by phased arrays, and circuit-switched communications links are rapidly being supplanted by packet-switched networks. In this rapidly changing world, the joint force needs a better jammer to keep up with the increasingly sophisticated moves of enemies. The program the Pentagon has created to meet this need is called the Next Generation Jammer.

The basic purpose of jammers is to deny enemies effective use of the radio-frequency portion of the electromagnetic spectrum. This can be done by simply overwhelming the relevant frequencies with so much energy that weaker signals cannot be heard, or it can be done more subtly by generating deceptive transmissions mimicking features of the hostile signal. Either way, jammers produce important intelligence about threats because they must be able to accurately detect and analyze hostile signals in order to counter them. Precision is crucial since the hostile signals cannot be defeated unless jammers transmit with sufficient power in the frequency ranges where the enemy is operating. On the other hand, if the power is too great and spills over into adjacent frequencies it can impair the transmissions of friendly forces.

The latter problem, called fratricide, has become a chronic issue with the current jammer. It sometimes interferes with global-positioning signals and datalinks on which the joint force depends. It also lacks the capacity to generate a sufficient number of jamming beams to cover all the threats in the increasingly dense electronic battlefield. More broadly, the basic architecture of the current jammer lacks the scalability, flexibility and supportability to cope with emerging threats. Some of the 2,500 jamming pods currently in use are nearly 40 years old, meaning they are hard to maintain and lack features needed to deal with today's digital dangers.

The Next Generation Jammer program was conceived to develop a modular jamming system that could cope with any radio-frequency threat likely to appear for decades to come. It will integrate both military and commercial technologies in an open architecture that can be easily upgraded as threats warrant while providing greater frequency coverage, radiated power,

steering agility and operational availability to the joint force. It will also manage power levels and signal transmissions to minimize fratricide. The requirement for such a system appears to be well understood by policymakers, but it must be fielded soon if the joint force is to avoid being overwhelmed by the digital onslaught of diverse adversaries.

(From an article by Loren B. Thompson, Ph.D., October 13, 2010, www.defpro.com/news/details/18669/. First reported by Interference Technology magazine, www.interferencetechnology.com/lead-news/article/us-joint-force-survivability-hinges-on-new-jammer.html on October 14, 2010)

609) Stray capacitance causes laptop problem

You might be interested in a small problem I had with a Modbus system. The client asked the university could someone show them how to automate their product testing. My proposed solution was to use RTDs and read them out via Modbus over RS485 and LabView. I purchased a cheap class II 24V power supply for powering the Modbus IO unit. I was also using a fully isolated RS485/RS232 -USB converter that claims DC isolation up to 3kV, and is powered from the USB bus only (www.audon.co.uk/usb101i.html).

The link was working fine when the laptop was running off battery, but died when the class 1 power supply was plugged into the laptop. It was discovered that the cheap power supply was taking the 0V up to half mains and had a touch current of 240µA. When the USB was grounded via the laptop 9 V AC was being dropped between the 0V and the RS485 bus, presumably via the protection diodes on the RS485 driver on the Modbus IO unit. 1V AC was being dropped across the RS485 unit between the USB ground and the RS485 bus.

The system worked correctly when the 0V on the Modbus unit was connected to the RS232 shell on the serial to USB converter. It seems that the isolated DC/DC power converter has a stray input-to-output capacitance of about 6.3nF, enough to allow 240µA to flow at 50Hz from a source voltage of 120V. Would you expect such a converter to have a ground terminal so you could connect the cable shield to it?

(From a correspondence with James Salisbury, September 2010.)

610) Electric scooter charger causes EMI

A colleague at work recently purchased a battery powered scooter. He found that the battery charger interfered with his terrestrial digital and analogue TV and his satellite system refused to work at all. He reported the interference to the importer but the battery chargers that they had in their own stock also caused interference.

At my suggestion he asked for a CE Declaration of Conformity, which he never received. After several weeks without being offered a solution, he contacted the local retailer prior to contacting Trading Standards and he was immediately offered his money back, which he accepted immediately.

It seems he was not the only person to complain about interference from the battery charger. One of his neighbours also purchased the same type of scooter at the same time and he has received complaints of interference from the people living on the other side of the road.

My colleague has learnt from this experience and has bought a petrol-engine scooter.

(Kindly sent in by Richard Harris C.Eng., MIET, of PIPS Technology Ltd, on the 15th October 2010.)

611) Europe's SMOS satellite is struggling with interference

Despite continued interference issues, Europe's SMOS satellite is transmitting valuable new data on the way water is cycled across the globe.

The satellite was launched in November to track changes in the wetness of soils and the salinity of the oceans using a microwave antenna.

The detailed maps will soon be released for the eyes of the scientific community. But there are still some issues as SMOS is blinded by radar networks and media links in some areas of the world.

The radio frequency interference is proving to be a frustration for the team. The part of the electromagnetic spectrum in which SMOS sees the planet is supposed to be reserved for Earth observation.

The problem zones are most notable in Southern Europe, the Middle East and along the Asian continent.

Dr. Yann Kerr, one of the SMOS principal investigators, told BBC News that these interferences are damaging the signal over a much larger area. Interferences in Africa, for example, particularly in Khartoum and South Africa, are affecting a good part of Africa, he added.

And Africa is “one of the areas of the world where information on soil moisture for better water resources management is crucial. So it's really a hindrance,” Kerr told BBC.

The European Space Agency satellite will complete its commissioning phase in the next month, and the first results from early observations were presented at the European Geosciences Union meeting.

SMOS has a single instrument – an interferometric radiometer called Miras. Miras measures nearly 26 feet across and has the appearance of helicopter rotor blades.

Miras measures changes in the moisture content of the soil and ocean salinity by studying variations in the natural microwave emissions (L-band) that rise from the surface of the planet. Tracking of these emissions will have broad applications, but should improve weather forecasting and warnings of extreme events, such as droughts or deluges.

Early data received suggests that Miras is performing relatively well. It has mapped out subtle features that will be of huge importance to hydrologists, meteorologists and oceanographers, as well as other fields.

During a recent rain event that soaked much of eastern Australia, Miras observed how the soil dried out over the days that followed.

“In several instances, we had phenomena that we identified but which seemed highly improbable,” said Dr Kerr. “We saw banana-shaped features in the data and we wondered if it was a problem with the instrument or RFI. But then we looked with rain radars and saw exactly the same pattern, so it was obviously a rain event.”

SMOS is also transmitting some fascinating data on the polar regions. Scientists can recognize where ice thins at the rocky edges of Antarctica. They are even able to see melt-water sitting on top of sea-ice.

The observations made using SMOS and Miras will be very useful to researchers studying changes in the cryosphere.

Progress is also being made in dealing with the man-made emissions that are interfering with Miras operational frequencies.

The European Space Agency is working with different authorities around the world – such as the International Telecommunications Union – to try to identify the sources of interference and shut them down. The SMOS team is also learning how to tune its algorithms to filter out some of the interferences.

The United States is also showing support for the cause. The US is expected to launch two L-band missions of its own this decade. SMAP will measure soil moisture, and Aquarius will monitor water salinity. The effort will be a joint venture with Brazil.

"In some ways it's a pity for SMOS that we are the first L-band mission in space, because we will basically look at all these things as the first people," commented Dr Susanne Mecklenburg, the SMOS mission manager.

The Chinese are possibly also working on an instrument that will hopefully help in switching off the sources over Asia, where a large part of the contamination is filtering through, Mecklenburg said.

(Taken from "SMOS Struggling With Interference", redOrbit, 5 May 2010, www.redorbit.com/news/space/1860648/smos_struggling_with_interference/index.html?source=r_space#)

612) Central locking activated near radio mast

Some years ago I was driving my car through Battle, in Sussex. Suddenly, for no apparent reason, the central locking activated. I hadn't touched anything since both hands were on the steering wheel, and the remote locking control fob was on the key which was in the ignition (so it hadn't got accidentally squeezed in my pocket).

I stopped the car and checked it over, but everything seemed to be in order so I continued my journey. This was the only occasion that the central locking ever self-activated.

The significant thing is that the incident occurred just as I was passing the local police station, which had a large radio mast. I can only assume that they were transmitting on a frequency which was the same as, or close to, the legitimate frequency used by my car for the remote locking control.

Obviously this is nothing like as serious as uncommanded and uncontrolled acceleration, or loss of brakes, but it was alarming at the time.

(Kindly sent in by a writer who wishes to remain anonymous, on 29th June 2010.)

613) 18 dead in TGV accident at Buizingen, magnetic fields suspected

La perturbation magnétique d'un feu de signalisation par des TGV est l'une des pistes suivies par la justice belge pour expliquer la catastrophe ferroviaire du 15 février en Belgique dans la commune de Hal, en grande banlieue sud-ouest de Bruxelles. Le feu de signalisation situé à Buizingen, dans la commune de Hal, est tombé en panne lundi, pour la seconde fois en quatre jours, passant au rouge sans raison apparente. Ces dysfonctionnements font s'interroger sur les raisons de ces incidents à répétition sur les lieux mêmes de la collision qui avait fait 18 morts il y a un mois.

L'une des causes possibles de l'accident citées par la presse au lendemain du drame était le non-respect d'un feu rouge par l'un des deux conducteurs du train. Le journal néerlandophone Het Laatste Nieuws assure mardi que le parquet de Bruxelles, chargé de l'enquête sur la catastrophe, va étudier la possibilité d'expliquer les pannes du feu de signalisation par "un champ magnétique fantôme". Le Syndicat indépendant des cheminots (SIC, minoritaire) pencherait également pour cette piste. "Il semble que le conducteur de train n'ait finalement pas commis de faute ce fameux 15 février, mais que le signal soit brusquement tombé en panne en raison du champ électromagnétique causé par le passage d'autres trains", indique un responsable du syndicat, Luc Pauwels, cité par le journal. Infrabel, le gestionnaire du réseau ferroviaire belge, reconnaît que le feu est perturbé "par quelque chose". "Il s'agit peut-être d'un champ magnétique, mais selon nous, la chance est mince. Lors du dernier incident lundi, il n'y avait pas de TGV à proximité. Il est possible qu'un champ magnétique vienne d'ailleurs, cela reste à examiner", a déclaré un porte-parole.

(Taken from the article: "Catastrophe de Buizingen : la justice belge suit la piste des champs magnétiques", by Le Monde and AFP, 16th March 2010, http://www.lemonde.fr/europe/article/2010/03/16/catastrophe-de-buizingen-la-justice-belge-suit-

la-piste-des-champs-magnetiques_1319934_3214.html#ens_id=1306014. The TGV is a high-speed railway train.)

614) Product standards inadequate for EMC compliance

Interference Case

In the 1970s the then man-made noise is mainly due to ignition impulses from motor vehicles. This has changed to MMN (Man Made Noise) due to the use of electrical equipment [6], sometimes high enough to adversely affect communication system performance [7].

Most existing radio receivers are designed for the case of additive white Gaussian noise (WGN), and their performance may deteriorate in other scenarios, for example when subjected to impulsive noise (IN) [9]. In rural environments the man-made noise can be approximated as WGN, but in urban and sub-urban environments the man-made noise is often IN. For digital communication systems, WGN does not represent a major problem as long as the mean power of the desired received signal is high enough.

The IN is harmful for digital communication because each pulse may cause bursts of bit errors and loss of synchronization. An extreme example of underestimating the MMN is the German Toll project [15, 16]. Several billions of euros were lost due to interference in GPS receivers in industrial areas and city centers, and the system had to be redesigned causing a long delay without income (of toll).

Another key issue is the classic interference case. This assumes a source of noise, on the road or from a neighbor, which is interacting with the wanted signal received with an antenna placed on the rooftop of a building, as shown in Figure 4 and 5.

In our modern living environment many electronic systems are used, including wireless communication systems. Especially in the transport sector a huge increase of wireless control systems can be observed, from the wireless bridge control systems on large cruise-liners, to the next generation passenger planes. This interference case, where many systems are packed in semi-enclosed environments, is not taken into account by most standards. In industrial production plants many wireless systems are already in use and many interference problems had to be solved, such as disturbed wireless data transmission in the 433 MHz band.

European Emission Standards

As an example, the EN55015 is the product family standard for electrical lighting and similar equipment. The frequency range covered is 9 kHz to 400 GHz, but the 1996 version contains no requirements for radiated emissions from 30 MHz and above. The Swedish Authority has found that some halogen lighting sets which are powered by an electronic transformer cause radiated emissions in frequencies not covered by EN 55015 [19]. When they tested it against the generic standards they found that the apparatus exceeded the limit by 30 dB and 31 dB at 30.72 MHz, and the disturbance level was extensive up to 50 MHz. The EN 55015 has been upgraded and now contains requirements up to 300 MHz [20].

The manufacturers of frequency converters had problems to fulfil the generic standards and used the same trick: they developed the IEC 61800-3 and EN 61800-3 on EMC for Adjustable Speed Electrical Power Drive Systems (PDS) [21]. Instead of leaving out a frequency range, complete categories were excluded. In the standard it is written ‘Where a PDS does not comply with the limits of category C1, the following warning shall be included in the instructions for use: Warning: In a domestic environment, this product may cause radio interference, in which case supplementary mitigation measures may be required ’. Does such a product not produce interference in other environments than the domestic environment? For equipment of category C2 an ‘information requirement’ has been added: ‘If a PDS does not meet the limits of category C1 or C2, a warning shall be included in the instructions for use stating that: this type of PDS is not intended to be used on a low-voltage public network which supplied domestic premises; radio frequency interference is expected if used on such a network. The manufacturer shall provide a guide for installation and use, including recommended mitigation devices’. We asked a manufacturer for the recommended mitigation devices. The answer was that such a filter did not exist…. In one case we asked for measurement results of a PDS, in this case conducted

emission. After several months and many repeated requests we received the data, showing compliance with the standard, and an overall emission level of 45 dBµV. But the equipment caused interference problems so we performed measurements. The emission level was 130 dBµV, 75 dB above the limit of the generic standard, and 85 dB above the level stated by the manufacturer. When confronted with this huge difference the manufacturer did not respond for 6 months, and finally replied with the statement that the wrong data had been sent erroneously…. The PDS appeared to be a C2 type, which actually means that the emission level is unlimited. Because the EN 61800-3 is a harmonized standard, a presumption of conformity with the EMC Directive [17] exists, and therefore a CE mark is affixed, even on equipment generating over 130 dBµV conducted emission. But is this approach in line with the essential requirements of the directive?

European EMC Directive.

Maybe we need lawyers to explain engineers that the EMC Directive is the Law. And the Law states the essential requirements. Harmonized standards are just useful to declare a presumption of conformity with the essential requirements.

Creating harmonized standards which exclude frequency ranges, such as the EN 55015, or allow essentially unlimited emission levels such as the IEC 61800-3, are in this way not useful.

However, these lightning and PDS systems are being applied in our living environments in huge numbers causing a very high noise level, as shown in Figure 2.

A court case could be very useful in sparking interest in this issue. Most national authorities do however not have sufficient means to carry out proper market surveillance and most are acting on a complaint basis only. A nice example is a case in Germany where a flat screen television set was causing interference in the HF (high frequency) radio band, around 3.6 MHz [23]. The German national authority checked and confirmed the interference, and concluded that the owner of the television is not allowed to switch on the television anymore, and if he would switch it on, then he would be charged because of offending the law. The supplier of the television repeated the EMC measurements at an accredited laboratory showing that the television was fulfilling the harmonized product standards. These standards however only consider conducted emission in the HF band, and no radiated emission. The television set fulfils the requirements of the harmonized product standard, but not the essential requirements which are stated in the EMC Directive. But instead of challenging the supplier in a court case the national authority followed the easy route by asking the consumer to switch off the television.

Conclusion

Man-made noise has changed in the last decades. Noise from automotive ignition reduced, but the man-made noise caused by electrical and electronic equipment increased in the conventional outside areas. Inside semi-enclosed living environments the man-made noise is much higher, 20 dB to sometimes more than 40 dB, than the free space noise levels described in ITU-R P.372. If new services are introduced in these environments, assuming the old man-made noise levels, then serious link problems are occurring: many examples of EMI after the introduction of new services have been reported.

The main cause of the high man-made noise level is the conventional interference case founding the current electromagnetic compatibility standards, which do not consider wireless communication systems operated in semi-enclosed environments. As a result, high emission levels in the standards for industrial environments have been allowed. A more critical issue is the wrong interpretation of the European EMC Directive by many people. This new-approach EMC directive states the essential requirements. Compliance with harmonized standards is only a presumption of conformity with the Directive. However, immoral harmonized standards resulted in a huge increase of man-made noise in our living environments, resulting in many EMI problems.

*(Extracted from: "*Gaps in the Application of the EMC Directive Due to Inadequate Harmonized Product Standards"*, by Frank Leferink, Technical Authority EMC THALES Netherlands; Full-*

professor EMC, University of Twente, The Netherlands; Frank.Leferink@UTwente.nl, frank.leferink@nl.thalesgroup.com, published in the IEEE EMC Society's Newsletter, Summer 2010 Issue, free from www.ewh.ieee.org/soc/emcs/acstrial/newsletters/summer10/PP_Gaps.pdf.) (The Editor notes - When IEC 61800-3 was first listed under the EMC Directive, the European Community Association of EMC Competent Bodies (ECACB) recommended that it be de-listed since it was totally incapable of ensuring compliance with the Essential Requirements of the EMC Directive. Up until that time, the European Commission had simply been adopting whatever IEC standards it fancied to serve under the EMC Directive, but following the ECACB's criticism of the adoption of IEC 61800-3 it appointed an EMC Consultant to make sure such mistakes were not made in future. Whether this was a sufficient response is questionable, because one EC EMC Consultant had been for many years preventing the adoption of the rail industry's product EMC standards, the IEC 50121 series, on the (perfectly reasonable) basis that they did not ensure compliance with the Directive's Essential Requirements – only for them to be immediately adopted by his replacement when his term of office ran out.)

615) Gaps in the IEC emissions and immunity standards between 2kHz and 150kHz, #1

The IEC's Advisory Committee on EMC (ACEC) is being urged to develop the IEC's emissions and immunity standards for the frequency range 2kHz to 150kHz. It is claimed that this is necessary because of a thorough change in use of the electricity, especially the introduction of modern electronic equipment having taken place during recent decades and, therefore, the increasing occurrence of voltage components above the present frequency range covered by harmonics standards and up to 150 kHz.

Certainly, to help save the planet from global warming (and increase sales) many manufacturers are encouraging the replacement of all DOL (Direct-On-Line) electrical motors by variable speed motor drives, which consume a lot less electricity on average over a typical year. Note the negative comments in Banana Skin 614 above about the product emissions standard for motor drives, IEC 61800-3!)

It is admitted that the available technical information is poor and that preliminary studies are probably necessary before a complete set of standards can be established. However, some relevant information is expected from CIGRE.

*(For more information, see: "*EMC Standards in the [2-150] kHz range*" by H Rochereau, November 2010, a document submitted to the ACEC meeting in Austin, TX. A preliminary list of standards, with their limitations or "under consideration" clauses, is given in an Annex to this document.)*

616) Gaps in the IEC emissions and immunity standards between 2kHz and 150kHz, #2

A CENELEC report in April 2010 highlighted EMI caused by interactions between automatic utility meter reading (smart metering) systems using PLC (power line communication) for data transmission, and a number of consumer devices like touch-dimmable lamps, kitchen and sanitary appliances.

It identifies the EM interaction mechanism, recognisable from the test results of investigations following customer complaints in several countries, and says that in principle, all CE-conforming equipment can be affected by such EMC phenomena, because at present none of their product standards (e.g. IEC/EN 55014) include testing for immunity against the effects of low-frequency EM disturbances in the range 2kHz to 150kHz.

It says that the equipment being endangered is most likely types that use circuits that use or detect pulses with a low repetition rate, for example for sensor buttons, motion detectors, etc. Equipment that uses such circuits with low current levels and high impedance are especially badly affected (e.g. touch-dimmable lamps).

It seems that the recent increase in the use of automatic utility meter reading (smart metering) systems using PLC (power line communication) has made visible the "tip of an iceberg in the EMC landscape". The report says it should be assumed that, in general, non-PLC equipment that generates voltages with similar frequencies to PLC might cause similar EMI problems, for

other types of equipment than those that have so far been investigated in accredited EMC test laboratories, following customer complaints.

(For a great deal more detailed information, see the CENELEC document: "Study Report from the SC205A Task Force on EMI between Electrical Equipment/Systems in the Frequency Range below 150 kHz (SC205A/Sec0260/R), April 2010")

617) Proposal for developing radiated emissions standards, 150kHz to 30MHz

A recent CISPR subcommittee H document says that the continuing development of consumer and industrial control and communications technologies makes it more desirable to develop radiated emission limits for 150 kHz to 30 MHz, where, at the moment, CISPR Recommendations only provide limits for conducted emissions.

The document says that although the approach of having only conducted limits in this frequency band has been satisfactory in the past, recent developments have raised concerns from radiocommunications service users about the validity of some of the assumptions underlying the idea that conducted emissions limits would be adequate on their own.

*(For full information, refer to: "*Development of Radiated Emission Limits*", CISPR subcommittee H document reference, CISPR/H/308/INF, 17 September 2010, marked: "For IEC use only".)*

618) Not using mains filters to save cost, cost US$54 million

A new offshore gas drilling rig cost US$ 500 million to build. It suffered from two separate EMC problems, one of which caused its large and powerful cranes to go out of control, causing very real safety hazards. After four months without drilling we were called in to fix the problems. After both issues were resolved the manufacturers of the rig counted the real costs of the problems, which amounted to over US$ 54m.

The manufacturer constrained us to use "quick-and-dirty" methods, just to remove the most obvious problems, rather than solve the problem at source as we wanted to. The oil business demands you hurry up and wait then buries everything when its attention span wanes, until the next disaster (or near one).

Much of the rig is still suffering the full force of the CM voltage noise caused by the absence of mains filters on any of its variable-speed motor drives, including the 700kW drives for the cranes. The manufacturer of the rig had made several similar offshore drilling rigs beforehand, and never fitted them with mains filters because "they were not needed" (they said) and so they saved their cost. Well, like all such bad engineering cost-cutting decisions, it ended up costing them much more than they had ever saved.

(A contribution in December 2010 from a verified source, who wishes to remain anonymous. The Editor is aware of many such costly incidents, some much more expensive, in almost every kind of electronics application, only some of which have been published in Banana Skins, or ever will be, because most of the people concerned are worried that even a "no names" anonymous contribution will somehow be traced back to them. A great deal of money is being wasted, because ordinary designers are not aware that such costly problems can occur, until they experience them first-hand!)

619) EMC successes and failures at CERN

CERN does not have a unified EMC policy or a centre of EMC competence. But we have various local efforts: the Large Hadron Collider (LHC, but not all units); large experiments (e.g. ATLAS and CMS); infrastructure (because of legal requirements and the need to boost reliability).

CERN has surprising competence: 28 scientists with at least partial EMC knowledge. Nevertheless CERN calls in EMC-firms for consulting, training, problem tracing and certification. The experience is a mixed one – it ranges from completely useless to very effective.

The ATLAS project initially adopted a "traditional" electronic engineering approach, based upon isolation and single-point earthing, which led to many functional problems. There were no immunity requirements, no limits on noise generation, and no cable routing rules. Later, a more organised approach including immunity verification was introduced, as part of a more organized EMC policy.

A success: the CMS Electromagnetic Calorimeter

This system operates over 5 orders of magnitude with high resolution. System flaws were detected and corrected at early stage, and immunity tests used throughout production. It has a very large UPS that allows for a largely transient free system for supplying critical parts. The CMS team had good EMC measurement apparatus and personnel with a high level of knowledge of EMC.

The project adopted an EMC Plan based on a safe layout (Power distribution & Grounding), then identification of the "emission" and "immunity" levels, to predict possible EMC problems. Tests included RF conducted noise CM and DM emissions (EN 55011 and 55022) from 9kHz to 100MHz, and mains harmonic emissions (EN 61000-3-3). Immunity testing included RF conducted noise (EN 61000-4-6), fast transient bursts (EN 61000-4-4), surges (EN 61000-4-5), supply voltage dips, short interruptions and voltage variations immunity test (EN 61000-4-11).

The results of the CMS EMC Plan included establishing the EMC ghost particle threshold for all systems. We put a lot of emphasis on immunity and good screens (shielding). We tried to avoid expensive solutions that do not do any good, but still we got useless separation transformers, useless isolation, unused cable screens (!!) and much too many stages of stabilisation. We had plenty of fights with the "isolationists" who see ground loops everywhere. The worst group ended up with open cable screens, causing the chambers to trigger even when the lights were switched on.

Signal processing was used to wipe out false triggers. For most noise we found either a good path, or ways to dissipate. We encouraged ground loops via insensitive system parts. Due to the dense packing most cables run extremely close to metallic surfaces which provides for "natural" noise immunity. We performed endless immunity tests and had numerous surprises. Biggest surprise: when checking the immunity of the bias voltage connection using a fast transient generator the preamplifiers were destroyed by 330 nA (!!) of common mode current at 40MHz – the divider RC-chain had an unanticipated 40MHz resonance.

The CMS Uninterruptible Power Supply (UPS) system provides 1.5 MVA of transient-free power with a steady-state voltage stability of under +/-0.5%, ensuring that the mains supply is free of micro-breaks and outages for the duration of the battery time.

A success: the LHC Energy Transfer System was tested for immunity against highest levels of transients and broadband noise, and needed quite some system modifications.

A failure: beam modulation with UPS noise

EMC standards were developed with the help of industry, using EMC science and compliance that started at 9 kHz. Frequencies below 9kHz were treated as power line frequencies and their harmonics. But the UPS makes switching noise, and we found that its fundamental was set to 8 kHz (to be below the frequency range measured by the relevant emissions standard!). It is so

strong that it modulates the LHC's beam. It also messes up power converters. This detail completely escaped our attention.

1000 horsepower compressor –failure of emergency stop safety loop

Due to lack of cooling water several interlocks opened to stop a 1000 HP compressor driven by a 3 kV high voltage motor. All interlocks, including the emergency stop button, failed to stop the compressor. Reason: Safety loop was extended into remote control room via cabling that picked up enough magnetic induction to keep the emergency relay energised despite multiple openings in its control circuit.

A failure: the Beam kicker concept

The kickers use transient magnets subjected to discharges from capacitor banks. The system layout uses the earth (ground) as the return path for many kA of transient current. It is very difficult to protect all other systems from the resulting common ground interference, and we have temporary system failures.

Conclusions: what can ITER learn from CERN's successes –and failures?

- Have a competence centre for EMC and give it clearance power for all systems, similar to what is done at the European Space Agency (ESA) and NASA.
- Have facts, measurement results and system layouts available for engineering at all times
- Do not embark on the "war of religions" – remain pragmatic and devise solutions that reply directly to the threat

CERN has learned to deal with EMC and EMC service providers. In-house competence is needed –the critical mass is about 5 persons. CERN experiments are independent and develop their own methods and approach. Good EMC solutions need a comprehensive understanding of systems.

EMC is the science of the "invisible schematic" – the visible (intended) and invisible (unintended) schematics together determine a system's performance.

Ground Loops are good! All common mode currents needs ground to return. Otherwise they use capacitive paths. Have as many ground loops as you can. Route noisy ground via insensitive parts. Draw the EMC schematic and simulate. Never depend on (single) ground for noise reduction. Somebody else could use it too…***Ground never swallows!***

Screens (shields) need to be adapted to the frequency range. Iron is a good dissipative screen (and is easy to weld). Cable screens are useless against kHz currents, and are subject to induction (continuous and transient). Screen continuity must be accompanied by quite some other measures, e.g. filtering.

EMC standards: EMC is big business with good salesmen. EMC standards give ideas but no solutions – they need to be checked against actual needs, and you could be forced to establish your own. In all cases: match the threats against the immunity.

Frequency domain and software solutions include signal processing to cancel unwanted stuff . CM to DM conversions are difficult to battle. Large effort in computer simulation and personnel is required. Very annoying: noise that attacks clocks - no software can replace a missing clock signal.

*(Developed from a presentation entitled "*EMC at CERN*" by Fritz Szoncsó (CERN SC) at the ITER Workshop on Earthing and EMC, held at Cadarouche, France, November 30 and December 1 2010. Fritz acknowledged the assistance of Fernando Arteche (CERN PH) Claudio Rivetta (FNAL).)*

620) Electromagnetic Field Problem Delays Rollout of New Commuter Railcars

Late last week, the planned introduction of the new Kawasaki M8 commuter railcars on the Metro-North Railroad New Haven Line was pushed back once more because trials in November showed "a problem in which the electromagnetic field on the M8 cars interferes with signaling equipment," the New Haven Register reported.

The New Haven Register article quotes Connecticut Transportation Commissioner Jeffrey A. Parker as saying that: "The electromagnetics are affecting signal equipment either aboard the train or signal equipment on the way-side of the train." The article at the CTPost further reports that Commission Parker said that the train propulsion system was the cause of the interference.

Last Friday's London Telegraph quoted Lord Berkeley, chairman of the Rail Freight Group, as warning that the introduction of new 4G cell phones could pose a safety risk to railroads in the UK. Lord Berkeley made his remarks during a debate on the UK government's plan - which was preliminarily approved - to allow the auctioning off of higher-megahertz areas of radio spectrum to cell phone operators, the Telegraph stated.

Lord Berkeley said that the spectrum being contemplated for auction was "quite close" to the one used by the digital radio systems that UK railroads recently introduced.

It would cost the railroads up to £100 million to contain and eliminate potential cell phone interference with train and signaling systems, Lord Berkeley said. Without such containment, there was a distinct possibility of "serious problems of (railroad) safety and operations."

(From: "Electromagnetic Field Problem Delays Rollout of New Commuter Railcars"*, posted by Robert Charette, Monday, December 20, 2010, IEEE Spectrum, http://spectrum.ieee.org/riskfactor/green-tech/mass-transit/electromagnetic-field-problem-delays-rollout-of-new-commuter-railcars-)*

621) Cosmic rays believed to be the biggest source of error in digital technologies

While increasing activity from the sun is a major focus of concern, there are also problems associated with the periods of low activity. The solar wind protects the Earth from bombardment by cosmic rays - high-energy particles that originate outside the solar system. 'When solar activity is low, cosmic ray activity goes up, and that's a big issue with aviation,' said Mike Hapgood from the Rutherford Appleton Laboratory. 'If a particle passes through a chip in a processing system, it can flip the bits, and that can change the data or the software response in an uncontrolled way.'

Cosmic ray hits are estimated by Intel to be the biggest source of error in digital technologies in systems both in the air and on the ground. They have been blamed for incidents such as one in 2008, when a Qantas Airbus A330 went into two rapid dives, losing 650ft and 400ft in rapid succession in a matter of seconds.

'For safety-critical systems, the main response is to make sure that we have at least triple redundancy,' Hapgood said. 'If you get a hit on one processing train, then the other two can outvote it.' Another option might be to increase the shielding around safety-critical electronics. But Hapgood added: 'You can't wrap an aircraft in lead shielding. The question is, if you have a severe cosmic ray episode or a severe solar storm, is there a chance that there would be sufficient hits to break that redundancy?'

Studies are under way to assess the vulnerability of the computer control systems inside vehicles. 'This is a serious issue because we don't understand all the implications of electronics in cars, in this context,' Hapgood said. 'The last thing you want is for a cosmic ray to set off your airbags on the motorway.'

(This is an extract from "Here comes the sun" by Stuart Nathan, The Engineer, 28 February 2011, on The Engineer magazine's website, this same article is called: "Flare path: protecting infrastructure from space weather", www.theengineer.co.uk/in-depth/the-big-story/flare-path-protecting-infrastructure-from-space-weather/1007598.article#ixzz1FS0ClutU. Dr Mike Hapgood is "Head, Space Environment" at STFC Rutherford Appleton Laboratory, Harwell, UK, visit: http://www.linkedin.com/in/mikehapgood.)

622) Space weather causes problems for electronics

As this issue's cover feature ("Here comes the sun") points out, satellites orbiting the Earth face their very own hazards, not just from the ever-increasing clouds of space debris that surround our planet but from space weather.

Our sun is the main culprit: with X-rays from solar flares, eruptions of protons and clouds of plasma all posing potential problems for a host of electronic systems. And when the sun's activity is reduced, and the protective benefits of the solar wind lessened, cosmic rays from outside the solar system pose a similar threat.

As we report, engineers and scientists are developing an increasingly detailed understanding of the potential terrestrial impact of these cosmic phenomena. And it doesn't look pretty. Everything from international finance to global security is reliant on satellite technology and researchers are increasingly concerned about the potential effects of space weather on our interconnected infrastructure.

Most researchers play down the prospect of solar storms bringing the modern world to its knees. This is a relief because it seems likely that we are likely to become more, not less, reliant on the satellites that underpin most areas of human activity.

(Taken from "Keeping our eyes on a volatile natural world", by Jon Excell, Editor, The Engineer magazine, 28 Feb 2011, page 5, www.theengineer.co.uk/opinion/comment/keeping-our-eyes-on-a-volatile-natural-world/1007601.article#ixzz1FTa09c3x.)

623) Solar activity bad for GPS and the high voltage infrastructure

Engineers are beginning to understand how space weather could affect today's technology. Solar flares can produce X-rays and several different types of charged particle

The Northern Lights are normally confined to the highest latitudes within the Arctic Circle, but one day in 1859 the shimmering curtains of light descended far down the globe. Miners in the Rockies thought the bright light behind the mountains was the breaking dawn, clocks being harder to come by than alcohol. The display reached as far south as the Caribbean.

While the auroral displays provoked wonder, for telegraph workers in Europe and North America the night was terrifying. The systems went haywire. Operators recoiled from electric shocks. Pylons emitted showers of sparks. Telegraph paper spontaneously caught fire. Some telegraph systems seemed to send and receive messages even though they had been disconnected from their power supplies.

Robert Carrington was the first to make the connection between the activity of the sun and geomagnetic storms, and the 1859 event, now known as the Carrington Superstorm, is the most powerful solar storm ever recorded. We now know a great deal more about solar storms.

However, we are only now starting to come to grips with the implications of the sun's behaviour on the technology that underpins a large proportion of our lives. While we know that solar storms of varying intensities will continue to occur, and events of the magnitude of the Carrington Superstorm have happened before, the effects of such a storm today could be much more far-reaching.

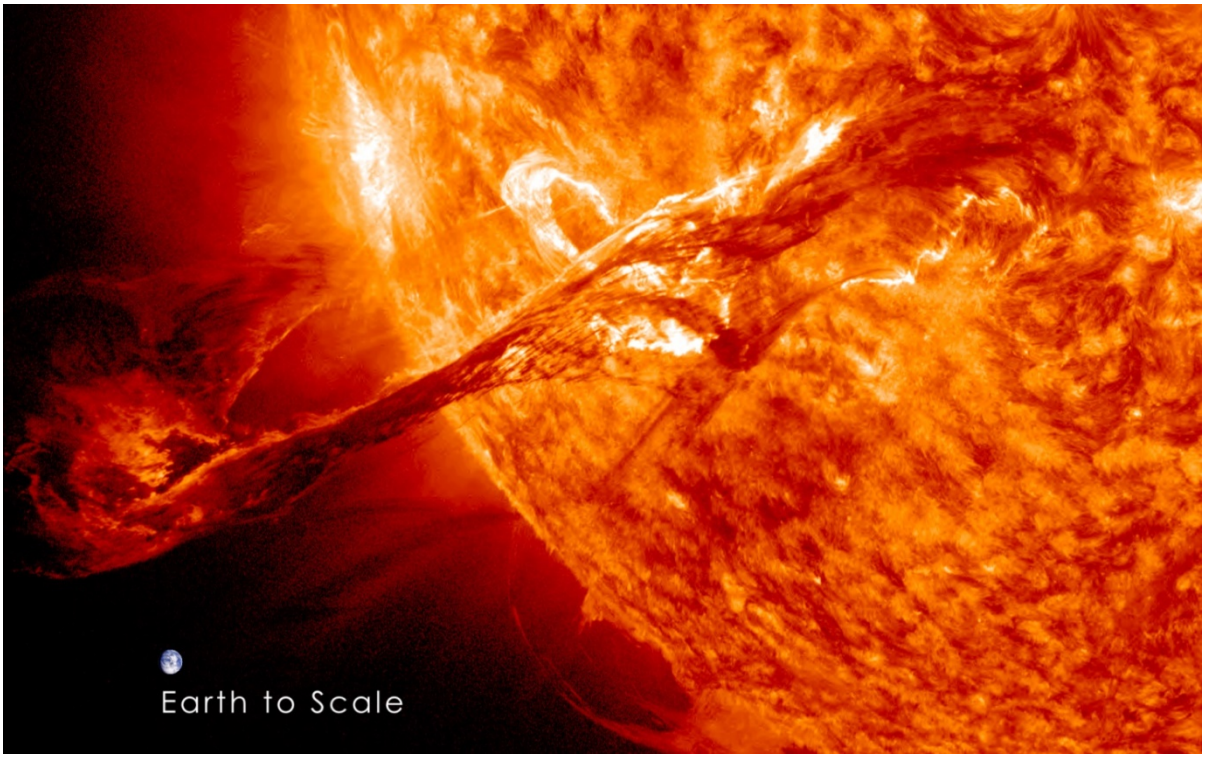


Figure 1 Example of a solar flare
(photo from the NASA Solar Dynamics Observatory, www.nasa.gov/mission_pages/sdo/multimedia/index.html#.VKGC3F4gA)

Back in the 19th century, society was mainly dependent on mechanical power in various different forms. Electricity had only recently begun to take hold in a few applications and its widespread use had yet to begin. But today, we're almost entirely reliant on electricity, and its cousin electromagnetism, in the form of radio, microwaves and other wireless data transmission techniques. It just so happens that these are the very forms of energy produced by the sun, and this is why solar storms could have such far-reaching effects on today's infrastructure. As we begin to realise just how interconnected these systems are, we are trying to understand the sun's effects and how to prevent the worst outcomes.

Prof Cathryn Mitchell of Bath University's department of electrical and electronic engineering, a specialist in the sun's effect on GPS, said. 'Sunspot activity is a non-stationary process, which means that we can't predict what's going to happen in the future by looking at what's happened in the past.'

Alan Thomson, Head of geomagnetism at the British Geological Survey added: 'The Carrington Storm caused fires and electrocuted workers at telegraph stations, but what else is there in these records we might find? How might such events affect today's power grid, if they were to occur again?'

There are three categories of solar effects - commonly known as space weather - on Earth-based infrastructure and orbital systems, Mitchell said. The first comes from electromagnetic radiation. Solar flares produce intense bursts of X-rays. Although the Earth's surface is shielded from X-rays by its magnetic field and the atmosphere, the radiation will knock electrons out of the gas molecules in the tenuous upper layers of the atmosphere. This will create radio activity that can interfere with satellite signals, especially from GPS. Moreover, in a phenomenon only discovered in 2005, the sun can sometimes produce radio bursts in the same frequency band as GPS and acts as a natural signal jammer. There is no way of predicting these events and no possible early-warning system, Mitchell said, because no warning can travel faster than the speed of light.

Solar flares can also eject sub-atomic particles from the sun, in a phenomenon known as coronal mass ejection (CME). Bursts of protons can erupt from the sun at 0.8 of the speed of light. 'For unshielded satellites and astronauts, these can be very dangerous,' Mitchell said. 'They can diffract GPS signals and cause them to break up.' This effect, known as scintillation, was thought to be relatively unimportant, she added, as GPS applications tend to rely on a reading from several satellites and it was thought that a scintillation event would only affect one satellite at a time. 'However, last year a solar event switched off all the satellites over a large area of Alaska.' Scintillation can last up to a few days after a solar storm.

The third effect is the most severe, caused by a phenomenon called plasma clouds, which cause ionospheric storms that can affect electricity distribution infrastructure by inducing large currents in transmission cables, feeding back to transformers, similar to the phantom currents in the telegraph lines in 1859.

Effects on GPS are among the most worrying results of space weather, and not just because of navigation. In fact, GPS is one of the prime examples of system interconnectedness. One of its most important uses is, in fact, in timing. Clocks on GPS satellites are used to handle the handover of mobile phone calls from cell to cell; they're used to schedule aircraft landings as well as in guiding aircraft; and they're an integral part of financial transactions, including share dealing and currency exchange.

'Large-scale systems across our economy are generally cobbled together from existing systems that weren't necessarily designed with that application in mind,' said Mike Hapgood of the Rutherford Appleton Laboratory. 'It's rare for something to be designed and implemented as a fully integrated system.' Because of this, he said, GPS has become hugely important, incorporated into many safety-critical, and potentially vulnerable, systems. 'The clocks on these systems are all synched to GPS, but the way to mitigate the risk posed by space weather is relatively straightforward. You need an accurate clock on the base station so you only have to synch occasionally, which will make sure that stations are resilient for, say, a month.'

Most observers agree, however, that predictions of infrastructure apocalypse in the press are overstated. 'People sometimes say that if we lose the signal from GPS then the internet will fail,' said Hapgood. 'I don't believe that's true.' The risk shouldn't be understated though. 'Insurance companies worry about one-in-200-year risks,' he added. 'And there was a big storm in 1999 that was a one-in-60-year event. We're looking at events that might happen once or twice in the lifetime of major electricity infrastructure, such as transformers. It is something that has to be considered.'

(Taken from "Here comes the sun" by Stuart Nathan, The Engineer, 28 February 2011. On The Engineer magazine's website, this article is called: "Flare path: protecting infrastructure from space weather", read the full version at www.theengineer.co.uk/in-depth/the-big-story/flare-path-protecting-infrastructure-from-space-weather/1007598.article#ixzz1FS0ClutU)

(A US Congressional Commission is investigating how to prevent total economic disaster lasting at least 5 years due to HV grid failure from a Carrington Superstorm type of CME, and another Commission dealing with the same problem but caused by the EM pulse from an atmospheric nuclear explosion (e.g. by a "rogue state"). Their deliberations and papers from their investigators have featured in previous Banana Skins, also see No. 624 below.)

(Note that this is not a US problem – any country that has a high voltage power distribution system, i.e. any developed nation, is equally vulnerable. Losing a national HV grid would take many years to recover from (no-one keeps stocks of the HV transformers that would be burnt out, and how do you make a new one without electricity?) and a Carrington type of CME would destroy HV grids over most/all of the world, whereupon society in developed nations would break down to levels not seen since the stone age within a few weeks.)

624) Permanent continental shutdown from electromagnetic pulse

A man-made Electromagnetic Pulse (EMP) is caused by a nuclear weapon detonated in the atmosphere. This threat is a realistic possibility in this day and age. In fact, two Congressional Commissions have recently warned that America could suffer catastrophic consequences from

a nuclear EMP attack by terrorists or rogue states. Their reports also point out that the U.S. can be protected if we act quickly. A House Homeland Security subcommittee is currently meeting and considering legislation, but very little has been done so far.

According to the Abstract of the original Report of the Commission to Assess the Threat to the United States from EMP Attack, U.S. Congress, 2004: "Several potential adversaries have or can acquire the capability to attack the United States with a high-altitude nuclear weapon-generated electromagnetic pulse (EMP). A determined adversary can achieve an EMP attack capability without having a high level of sophistication."

An EMP attack can cripple our infrastructure causing all of our electronic equipment and Infrastructure to fail. That means even basic modes of emergency response, like cars, planes, and other emergency vehicles, may not even start. Current emergency planning is primarily based upon short-term disasters, and is heavily dependent upon assistance from peripheral communities; unfortunately, an EMP could have long-lasting and wide-spread effects that are not adequately addressed by current planning. Moreover, availability of fundamental resources such as our food, water, and medical supplies would almost certainly break down.

Don't think it can happen? Increasing nuclear terrorist threats like those of North Korea and Iran can disable the entire power grid in North America are a clear and present danger. Terrorists and rouge nations don't even need accurate or long range ballistic missiles. An EMP attack can potentially be carried out by launching readily available Scud missiles from a barge off of our coasts.

Our ongoing development and increasing reliance on electronics and technology makes us extremely vulnerable to EMP threats, We invite you to join us at the conference so that we can help you better understand the impact of EMP and how it affects you, and feature some proactive, hands-on ideas to protect our infrastructure from the devastating effects of EMP.

(Taken from an invitation to take part in the conference "Protecting America Against Permanent Continental Shutdown From Electromagnetic Pulse: A National Conference", organised by EMPACT America Inc., September 8th-10th, 2009, Niagara Falls, NY. www.empactamerica.net. Sorry, but it's too late to register.)

625) Susceptibility of GPS

It is also safe to say – without any sense of surprise – that GPS availability cannot be assured under all conditions, as it is susceptible to both RF interference and the laws of physics regarding L-band radio waves.

(A very small extract from "Changing the Game Changer, The Way Ahead for Military PNT", by Jules McNeff of Overlook Systems Technologies, in InsideGNSS magazine, Nove/Dec 2010, visit www.insidegnss.com/auto/novdec10-McNeff/pdf for the full article. By the way, PNT stands for Positioning, Navigation and Timing.)

626) Jamming GPS with a pocket-sized device

BAE Systems, the company behind the technology, says that because GPS signals are extremely weak by the time they reach the Earth's surface, jamming is an increasingly common battlefield problem.

"Just a small pocket-sized device can jam signals over several hundred metres," explains Dr Ramsey Faragher, a higher scientist in advanced information processing at BAE Systems, who developed the prototype solution. "What's more, anyone with a basic knowledge of electrical engineering can buy components on the high street and make a battery-powered GPS jamming device within an hour. I was at a navigation conference last week and a third of it was dedicated to the issues of jamming and spoofing.

(Taken from "Military 'super GPS' tracks without satellites", by Dominic Lenton, Editor, Engineering & Technology magazine, 28 Feb – 13 March 2011, page 8, www.theiet.org/engtechmag)

627) EM pulse could be used to detonate IEDs in Afghanistan

Soldiers in Afghanistan could detonate improvised explosive devices (IEDs) with a remote tool created by researchers in Switzerland.

The technology can activate homemade landmines at a distance of up to 25m by transmitting electromagnetic waves at a range of frequencies. This inducts a current in the devices and causes them to explode.

Rachidi and doctoral students Félix Vega and Nicolas Mora first generated an electromagnetic wave with a broad frequency spectrum of up to 1GHz. But because it only transmitted to each frequency for a very short time, it didn't provide enough energy to detonate the IEDs.

They then realised that the general configuration of most IEDs meant that they operated within a smaller frequency range and so the team was able to target the electromagnetic pulse to deliver enough energy.

EPFL's prototype is specifically designed for use in Colombia, but Rachidi said the principle would be the same for devices in Afghanistan or any other country.

The next stage of the project is creating a more compact and robust prototype. Rachidi said the device could be ready for use within five years with the right commercial partner.

He added that no device could provide a 100 per cent solution to the issue of IEDs and that he expected the technology to be used alongside existing methods of detection, such as sniffer dogs.

(Taken from "Remote tool could be used to detonate IEDs in Afghanistan", by Stephen Harris, in The Engineer magazine, 28 Feb 2011, page 10. For the full article, visit: www.theengineer.co.uk/sectors/military-and-defence/news/remote-tool-could-be-used-to-detonate-ieds-in-afghanistan/1007487.article#ixzz1FTZbNdlt)

628) EMI at the White House

Mr Thomas also resolved interference problems in the White House radio room when he discovered that fluorescent lighting from the kitchen was the culprit.

(Taken from: "An Archaeological Expedition to Washington DC unearths engineering gold" by Mike Violette of Washington Labs, who was writing about Leonard Thomas, Fifth Secretary of the IEEE EMC Society, IEEE EMC Society Newsletter, Issue 218, Summer 2008, page 40, http://www.emcs.org/.)

629) Woman's Radio Voice Explodes Missile

An interesting article in the Newsletter was titled "Woman's Radio Voice Explodes Missile." The story was written by Anita Ehrman from the Hearst Headline Service and appeared in the Hearst papers on June 12, 1959; it read like this: "Was it a woman's voice on a short-wave radio frequency which inadvertently exploded an American missile in outer space? This is the big mystery which puzzled U.S. scientists and was divulged by American delegates to a secret mission of the UN outer-space committee.

According to UN informants, American delegates to the meeting astounded attending scientists by revealing to them that a human voice on a short-wave frequency can have the same effect on the behaviour of an outer-space missile as that of its assigned radio signal. After a U.S. missile had exploded prematurely after it was launched from its pad, an extensive investigation led to a taxi office in San Diego, California which had short-wave communication operated on a frequency similar to that used for the missile.

Experts concluded that the voice of a woman dispatcher in the office was so pitched as to be identical to the radio signal used to explode the missile in case of emergency and that, therefore, it was her instruction to a cab driver which caused the missile to explode. On the basis of this information, the UN scientists agreed in the secret session that urgent international attention should be given to protect radio frequencies used to transmit information between spacecraft and the earth."

(Taken from the "EMC Society Newsletter Review – 50, 25, and 10 Years Ago. 50 Years Ago – Institute of Radio Engineers – Professional Group on Radio Frequency Interference (PGRFI) Newsletter, Number 6, July 1959 – Edited by Rexford "Rex" Daniels" in the IEEE EMC Society Newsletter, Issue 222, Summer 2009, pages 33 and 34, http://www.emcs.org/.)

630) Majority of equipment using radio spectrum does not comply with R&TTE Directive

A market-surveillance report conducted in 2003 in 19 European Conference of Postal and Telecommunications Administration (CEPT) countries showed that 76% of equipment relying on the radio spectrum failed to comply with the R&TTE Directive. Five years on from that report, approximately 90% of the manufacturing of such products has moved from Europe to China and other Asian countries.

Fortunately, the EU is currently reviewing how the safety of products that rely on the shared radio spectrum can be improved. High-tech equipment has traditionally benefited from a high level of compliance and continues to do so as the manufacturers in this sector follow established protocols to ensure that their products comply with all applicable legislation. However, it is the area of mass-produced electrical goods for the general consumer market that is causing concern, with products that are not compliant increasingly trickling into the supply chain.

This isn't just speculation on TÜV Product Service's part. Another CEPT market-surveillance campaign conducted in 2005 showed that 88% of the CE-marked terminal equipment checked failed to comply with the directive's technical requirements. The main problems were found with low-tech, low-cost products.

This is no surprise as the new directive could be seen to encourage a lackadaisical attitude among some manufacturers as they no longer have to test in order to prove certain performance requirements for connection to the network. The apparent justification for this "dumbing down" of the directive is that the EU believes market forces will exclude any terminals available on the market that turn out not to perform well.

But manufacturers could find themselves using products that actually interfere with each other – the new wireless LAN in the office could render a wireless mouse or other Bluetooth products useless. The utopian idea behind the R&TTE Directive that self-certification would make market growth possible and that market forces through user dissatisfaction would identify non-compliant products simply won't work. For example, someone could be happily using his or her home wireless LAN totally oblivious to the interference that it is having with the neighbour's television. Looking further up the supply chain, wireless LAN equipment used in the office or home could interfere with military radio communication.

CE marking can no longer be relied on to prove that a product meets the R&TTE Directive's requirements. The increase in consumer demand for electrical goods has exploded over the last ten years, so that much of that additional manufacturing capacity has moved outside Europe to markets such as Asia and the Middle East.

Due to language issues, these manufacturers could be misunderstanding the Directive requirements – giving the CE badge to products that would otherwise fail tests. The CEPT market-surveillance campaign backs this up as it showed that many of the products that did not pass R&TTE compliance tests also had no self declaration of conformity assessment associated with CE marking. The majority of these products were produced in China and brought into the EU without the importer being aware of relevant legislation. However, not all the problems are entirely down to the new economies emerging outside Europe.

(Taken from: "Robust tests and less confusion required from EU Radio-Spectrum-Integrity review", by Jean-Louis Evans, Managing Director of TÜV Product Service, in EPN magazine, Issue12, Dec 2009.)

631) Wireless Coexistence guidance

The reliable operation of wireless radio systems in production plants is possible. This has been confirmed by studies carried out by the 'Wireless in Automation' working group of the ZVEI (German Electrical and Electrical manufacturers' association). The brochure Coexistence of

Wireless Systems in Automation Technology published by the ZVEI provides explanations on the factors that need to be taken into account.

Wireless systems such as WLAN or Bluetooth have been used in the home and office for many years. They are also being used increasingly in the automation systems of plants and machines. However, the requirements on availability and interference immunity associated with such applications are often considerably higher. For example, applications may require defined response times with very high availability.

A number of electrical automation manufacturers therefore jointly investigated the topic of coexistence of wireless solutions in industrial applications under the umbrella of the ZVEI. For the purpose, ifak – Institut für Automation und Kommunikation e.V. Magdeburg – was asked to carry out extensive measurements: the update times of around 120,000,000 packet transmissions were measured, processed and statistically evaluated in approximately 400 practical test cases.

The most important findings have been summarised in a brochure which explains the important characteristics for differentiating wireless systems, their behaviour during parallel operation and measures for coexistence management. It makes users aware of why and how they should consider the topic of coexistence of wireless systems. The brochure shows how simple it is to avoid mutual interference and to implement interference-free parallel operation. It can be downloaded as a PDF file at: www.zvei.org/automation/publication.

(Taken from "Wireless Coexistence: How to reach a peaceful get-together", in Control Engineering Europe magazine, Nov-Dec 2009, page 6, www.controlengineeringeurope.com)

632) Harmonic hotspot

When capacitors on a power quality filter at a power plant in Queensland, Australia failed, the problem was traced to a large sixth harmonic (300Hz) resonance condition set up between a 50kV railway supply harmonic filter and the power supply system. Power transmission engineers were aided in their troubleshooting by the graphical display and management software, DADiSP.

When the problems were isolated it was found that the transformers under investigation had gone into saturation in the presence of non-symmetric load currents – currents containing both even and odd harmonics. The sixth harmonic components were found to be exciting the resonant condition and particularly bad resonances were found to occur when the large power transformers were energised in the vicinity of the filter bank. These resonances produced high voltage stresses on the capacitors thus contributing to their failure.

(Taken from "Troubleshooting aid locates harmonic hotspot", in DPA Electrical and Electronics magazine, October 2009, page 23, www.dpaonthenet.net)

633) EMC and high-power grid-connected photovoltaic (PV) plants

As concerns the conducted RF emissions of the inverters, international standards for industrial and domestic environments enforce the maximum levels on the AC side. However, for the DC side, no standard is available (although in the European project, possible limits have been examined and proposed).

A simple (and still common) approach is to use for the DC side the same RF limits as in the standards for AC connections. After a first period, when inverters emitted high levels of RF disturbances on the DC side, manufacturers soon realized the importance of reducing them' today, modern inverters from experienced manufacturers comply with AC standard limits. In any case, when several inverters are used, parallel –connected in the same PV system, the disturbances generated by single inverters can add up so that the limits may be exceeded.

An important issue to be pointed out here is that, for the main terminals disturbance voltage in the frequency band 150kHz-30MHz, the Standard EN-61800-3 (that specifies EMC requirements for power drive systems (PDSs) and to which industrial PV inverter can be assimilated) imposes limits higher than those imposed by the Standard EN-55011 for industrial, scientific, and medical (ISM) equipments.

The disturbance voltage limits (average and quasi-peak) for PDS of category C3 (i.e., PDS of rated voltage less than 1kV) intended for use in the second environment (industrial), with rated nominal current higher than 100A, are shown in Fig. 6, while the limits for Group 1-Class A equipments (suitable for use in all establishments other than domestic) are shown in Figs. 9 and 10.

It is, thus, evident that, roughly speaking, the power inverters are allowed to produce more disturbance.

(Taken from "EMC issues in High-Power Grid-Connected Photovoltaic Plants", by Rodolfo Araneo, member IEEE, Sergio Lammens, Marco Grossi, and Stefano Bertone, IEEE Transactions on EMC, Vol. 51, No. 3, August 2009)

634) FCC issues citations for marketing cell phone jammers

The Federal Communications Commission (FCC) is dramatically increasing its efforts to deter the marketing and sale cellphone jamming devices, as reflected in a series of recent enforcement efforts against device resellers.

In the space of just two weeks during late January through early February 2011, the FCC issued citations against three online resellers for marketing cellphone jamming devices through their websites. Two of the resellers, DeadlyDeal.com and ContrexCommunications.com, admitted listing such devices for sale, but informed the Commission that they had immediately removed from their website any and all references to cellphone jamming devices. The third reseller, DealExtreme.com, has not yet responded to the FCC.

Separately, the Commission has also issued a citation against a Georgia company for marketing a device named the TxTStopper. According to the company, Share Enterprises, the TxTStopper was specifically designed as a safety device to prevent texting and cellphone communications within a moving vehicle. However, subsequent testing by agents concluded that the TxTStopper was a cellphone jamming device that effectively blocked cellphone communication both inside and outside of the vehicle.

Finally, in perhaps the most egregious case related to the illegal marketing and sale of cellphone jamming devices, the Chinese company that manufacturers the TxTStopper has been ordered to show cause why an FCC-issued equipment authorization should not be revoked, in light of evidence that the company applied a legally obtained FCC ID to the illegal cellphone jamming device. Should the Commission's investigation substantiate the allegations, the company could face a financial penalty in the amount of $112,500.

More information about the above citations is available at http://www.fcc.gov/Daily_Releases/Daily_Business/2011/db0126/DA-11-125A1.pdf (DeadlyDeal.com), http://www.fcc.gov/Daily_Releases/Daily_Business/2011/db0126/DA-11-135A1.pdf (ContrexCommunications.com), http://www.fcc.gov/Daily_Releases/Daily_Business/2011/db0209/DA-11-248A1.pdf (DealExtreme.Com), and http://www.fcc.gov/Daily_Releases/Daily_Business/2011/db0209/DA-11-247A1.pdf (Share Enterprises).

The Order to Show Cause issued to Shenzhen Tangreat Technology, the manufacturer of the TxTStopper, is available at http://www.fcc.gov/Daily_Releases/Daily_Business/2011/db0209/DA-11-246A1.pdf.

*(Taken from "*Commission issues citations for the marketing of cell phone jammers*", In Compliance magazine's on-line newsletter "The World IN Compliance", March 3, 2011, http://www.incompliancemag.com/index.php?option=com_content&view=article&id=614:commission-issues-citations-for-marketing-of-cell-phone-jammers-&catid=1:latest-news&Itemid=19)*

635) Military RF jammers are big business

Major investments have been made to develop and improve jammers for a variety of platforms, including ground vehicles, portable systems, unmanned aerial vehicles (UAVs), and unmanned ground vehicles (UGVs). In fact, market analyst Forecast International predicts a $28.4 billion

market for RF jammers and other electronic warfare (EW) equipment over the next decade, representing more than 45,000 system sales.

(From "RF Capture And Playback Checks IED Jammers", by Darren McCarthy, RF Technical Marketing Manager for Tektronix, page S18 of "Defense Electronics", a Special Section in Microwaves & RF and Electronic Design magazine, www.mwrf.com, January/February 2011. This article does not yet appear to be available via the Internet.)

(Apparently the Chinese Military establishment also read the above article, because in the Sunday Times of March 6th, 2011, on the back page of the "News Review" section, it says "The Chinese Army is training 10,000 pigeons who would deliver messages in the event of a high-tech communications failure. "In modern warfare, the pigeon is indispensible," said Chen Hong, an air force expert. "We have as many military pigeons as there are soldiers in the Swiss Army".

It is not clear why he compares the number of pigeons with the Swiss Army, unless he expects to win a war against Switzerland by pecking its soldiers until they run away. But the general relevance to Banana Skins is that pigeons are resistant to electromagnetic jammers, even of the most sophisticated type, and also to nuclear electromagnetic pulse, that other nemesis of electronic communication systems. And just in case you were thinking of it, any pigeons so close to a nuclear blast to be cooked, would be too radioactive to safely eat).

636) Digital cellphones interfere with hearing aids

The introduction of digital wireless technologies in the mid-1990s created a potential new barrier to accessible phone communication for hearing aid wearers. When digital wireless telephones are in close proximity to hearing aids, interference may occur. The interference may be heard as a buzzing sound through the wearer's hearing aid (Skopec, 1998). Interference does not occur with all combinations of digital wireless telephones and hearing aids. However, when interference does occur, the buzzing sound can make understanding speech difficult, communication over cell phones annoying and may render the phone completely unusable to the hearing aid wearer (Hansen and Poulsen, 1996). It's likely that hearing aid wearers will approach audiologists for information about this complex issue. This article will address many of the issues relating to cell phones and hearing aids.

Analog coding involves making an electronic copy of the speaker's voice. This electronic copy is transmitted between the cell phone and base station and across the network using radio waves - not unlike the way radio stations transmit music and talk programs to portable and car radios. While the analog cell phone is in communication with the analog network, an electromagnetic field is present around the antenna of the phone. This electromagnetic field does not present any inherent barriers for people using hearing aids.

Despite their advantages, digital wireless telephones and service have a potential inherent drawback for people who use hearing aids. Digital technology codes and transmits the telephone conversation differently than analog technology. Digital coding interprets and presents the speaker's voice as a series of numbers, O's and I's. The digital code is transmitted between the cell phone and base station and across the network using radio waves. When the digital cell phone is in communication with the digital network, the electromagnetic field present around the phone's antenna has a pulsing pattern (Kuk and Nielsen, 1997). It is this pulsing energy that may potentially be picked up by the hearing aid's microphone or telecoil circuitry and heard as a "buzz."

Audiologists should encourage hearing aid patients to be persistent as shoppers. Hearing aid wearers may find one technology works better than another with their hearing aid. If they have a problem with one brand of service, encourage them to try another. There is anecdotal evidence that CDMA service causes less audible interference than the TDMA technologies. Audiologists might suggest that their patients start with this technology whenever the option exists.

Kuk, F. K., & Nielsen K. H. (1997). Factors affecting interference from digital cellular telephones. The Hearing Journal, 50(9), 1-3.

(Taken from "Digital Wireless Telephones and Hearing Aids", by Linda Kozma, M.A. CED, CCC-A, originally published in Audiology Online (www.audiologyonline.com) on 2/12/2001, http://tap.gallaudet.edu/voice/wirelesshearingaids.asp)

637) Power supply spike damages battery chargers on autonomous road vehicles

The journey was not without problems, ranging from administrative issues over the validity of visas to technical glitches that included the simultaneous failure of all four battery chargers, caused by a spike from the power supply.

(Taken from "Driverless vehicles complete Silk Road challenge", by Lorna Sharp, http://viac.vislab.it, in IET Engineering & Technology magazine, 13 Nov - 20 Dec 2010, page 13, www.theiet.org/magazine)

638) Power lines jolt cyclists

A spin on his new Ridgeback Horizon bike turned out to be a shocking experience for touring cyclist Alan Reid. Riding beneath high-voltage power cables, he was zapped by a "microshock".

Reid wasn't hurt but said the experience was alarming. The 55-year-old was cycling in Gleniffer Braes, south of Paisley in Scotland. He moved his hands on his bars and got an electric shock in his fingertips.

"I looked around and saw the power lines above me," he said. "It was like a static shock off a carpet but stronger. It has happened to me two or three times since but always in different locations."

Reid's experience is not unique. National Grid, which manages power lines all over Britain, said it gets "a slow trickle" of inquiries from cyclists about microshocks.

According to Stewart Larque, a National Grid spokesman: "Cyclists riding beneath power cables can become charged by the electric field. When they touch a conducting object, they discharge."

Larque said the microshocks most commonly occur when a rider moves their hands from an insulated part of the handlebars so their fingers brush against the brake lever, or when the inside of the thigh comes close to the seatpost or saddle rails.

"In the highest fields – that is, under spans of 400kV power lines with the lowest clearance – these shocks can be mildly painful," said Larque. "They are certainly disconcerting because they are usually unexpected. The charge is small but it is concentrated on a small area of skin."

Larque added that most reports from shocked cyclists are at the level of nuisance or irritation. "We are only aware of one person choosing to see a doctor after suffering a microshock while riding a bicycle, and we are not aware of any cases involving a visit to A&E," he said.

"People who contact us largely do so because microshocks are unexpected and not understood. When they do arise and how easy it is to avoid them, most people seem perfectly content."

Whenever I'm out on my regular Sunday ride, I now keep a sharp eye out for pylons striding across the countryside. If I have no alterative but to ride underneath these high-voltage cables, I make sure to keep at least one hand in contact with the metal of my bike to avoid shock.

One or two disbelieving friends who I told about it have adopted the same technique since hearing about Alan Reid's experience. The only way to avoid the risk would be to remove the insulation from the handlebars so your hands are always in contact with the bike's metal surface. In the sub-zero temperatures that we're expecting, that could make riding uncomfortable.

Reid, who rides 2,000 miles a year, said the experience was so unpleasant that he now looks out for power lines and avoids being shocked by resting a finger on the metal brake lever while passing beneath cables.

(Taken from: "Power lines give a jolt to the unwary rider" by Will Bramhill, the "Cycle Guy", in The Sunday Times, 28 Nov 2011, "InGear" section, page 9, www.thesundaytimes.co.uk/ingear)

639) US power grid gets less reliable

The US electrical grid has been plagued by ever more and ever worse blackouts over the past 15 years. In an average year, outages total 92 minutes per year in the Midwest and 214 minutes in the Northeast. Japan, by contrast, averages only 4 minutes of interrupted service each year.

(Taken from "U.S. Grid Gets Less Reliable", by S Massoud Amin, IEEE Spectrum, January 2011, page 64, www.spectrum.iee.org)

640) Airplane experiences uncommanded thrust reduction due to replacement module

The second example, relates to an amplifier associated with a temperature sensor on an aircraft engine control system. In this case the legacy analogue item was replaced with a solid state amplifier.

The technical evaluation rightly considered the form, fit and function of the new amplifier, however these attributes were all considered only in the positive sense. Failure to adequately consider the ways the amplifier might fail that might be different to those of the previous technology amplifier lead to an aircraft incident.

During flight, the aircraft experienced a reduction in thrust, without pilot command, in all four of its engines. The cause was the replacement amplifier exhibiting an alternative behaviour during a power-supply event, causing the engine control system to reduce power.

(Taken from "Technical substitutions in safety-related system – not just form, fit and function", by Derek Reinhardt, Safety-Critical Systems Club newsletter, vol 20 no. 2, Jan 2011.)

641) Stubborn RF problem with the Beatles' Abbey Road console

The original Abbey Road REDD 37 is now owned by Lenny Kravitz. However, when he purchased the equipment, it was beset with ground noise and RF problems.

Technical services specialist Studio Electronics was called in to resolve the problem. Company founder David Kulka explained the dilemma: "There was a stubborn RF problem, as audio from a nearby FM transmitter was leaking into the output buses. We switched on the console and, after bringing a few faders up and figuring out how to route audio through the monitor section, brought up the volume pot. There it was – a filtered high frequency sound – the top end of a tune the station was playing. RF energy was finding its way into the REDD 37 and being converted to audio by something in the console's electronics."

The historical importance of the RE DD 37 imposed a condition. "With any other console, a minor circuitry change would not raise eyebrows," noted Kulka, "but, in this case, it was out of the question. If a component had failed, I would replace it, preferably with exactly the same part, which we would somehow locate. But modify a Beatles console? No way!"

In this instance, the problem was the microphone and echo send cables. "I built a short version of the mic cable, with the two signal wires at the male end wrapped around ferrite beads," Kulka revealed. "The female end of the adaptor plugged into the real mic and the male side plugged into the REDD 37. The filter chokes did the trick and the RF interference was gone."

(Taken from "Under New Ownership", New Electronics magazine, 11 Nov 2008, page 16, www.newelectronics.co.uk)

642) ESD affects semiconductor manufacturing equipment

In addition, ESD events produce electromagnetic interference (EMI) that can cause equipment malfunctions, lockups, and direct damage to products via radiated and conducted forms.

(Taken from "Applying E78 to Semiconductor Wafer Chambers" by Roger Pierce and Brad Williams of Simco, Conformity magazine, November 2008, pages 36-41)

643) RFI: Invisible Killer (from 1961)

Does Radio Frequency Interference – today's electronic clutter of the air-waves – cause those mysterious plane crashes, missile failures and communications blackouts?

On the docks at the Oakland Army Terminal in California the eerie, invisible "force" had stabbed once more. The giant steel unloading cranes seemed haunted with electrical current, and crews

were being shocked and painfully burned. The stevedores had been unloading ammunition ships; now they laid down their equipment and refused to work. For too long they had moved gingerly, trying to outmaneuver the peril.

Investigators diagnosed the Oakland mystery as another attack by an increasingly active foe called Radio Frequency Interference – or RFI. Anyone who owns a television set has probably been bothered by RFI; it can split the TV image into fragments or obscure it with flickering bands or specks of light. For the viewer the interference is merely annoying. But RFI at its worst imperils human life and property. It blocks communications. It regularly holds up the launching of some United States missiles and has caused others to malfunction temporarily in flight. It has made the nation's military defense system and attack potential a frightening gamble. Some electronics specialists are convinced that unless Radio Frequency Interference is reduced drastically, the country-must someday consider dictatorial control by the Federal Government of all electrical energy. For RH is the result of energy that all types of electrical devices spew into the air; it is an emission of electrical energy from one device strong enough to upset the operation of another.

At the Oakland Terminal, for example, investigators found that the steel unloading cranes were acting as antennas, picking up transmissions from daytime radio station KSAY, whose transmitter is a half mile away. The cranes in turn threw off an electric current that burned the crews. This electronic freak has defied remedy, and the Army has been forced to unload its ammunition and other supplies at night, when the station is off the air. At last reports the Army was suing for a permanent solution to the problem – a court-ordered change of KSAY's power or a change in the location of its transmitter.

Stories about RFI often crop up in newspapers, mainly as amusing, offbeat occurrences. The radio-controlled garage doors of a Greenwich Connecticut, doctor open inexplicably during the night, and the papers report that he is troubled with electronic "spooks". But the real peril in RFI seldom makes news.

In the not-so-distant days of Edison's first electric light and Marconi's first wireless set, there was no problem of Radio Frequency Interference. RFI arose as the output of electrical devices soared to fill human demands for more and more mechanization, greater and greater comfort. Millions of devices now clutter the air with their electrical emissions. A partial list would include about 2,000,000 radio transmitters in the United States alone, the thousands of public and private TV transmitters, the millions of receivers, plus medical and business machines, radars, fluorescent lights and any number of household appliances. It would be impossible to inventory all the potential sources of RFI.

If the waves of energy put out by all the electric and electronic devices in the world could be observed in the air as moving strands of wife, we would find ourselves enmeshed in an amazing jungle of contorted metal. If by some legerdemain we could separate the wires and trace them to their origins, we would see that they vary in shape and length – some fat, some thin, some many thousands of miles long, others as short as five or ten feet – or even inches. The wires would be extremely active, undulating out from their points of origin and darting hither and yon like nervous reptiles, seeking entry to any other electrical devices attuned to their size.

The diabolic thing about RFI is that the interfering equipment can range from the most potently complex to the simplest and smallest. Emissions from a radio station in Spain early this year hampered the tracking of a U.S. satellite before the offending signals were pinpointed and eliminated through the co-operation of the Spanish government. At Minneapolis, worn contacts in an electronic-doorbell system in a private home let current shoot out into the airways briefly every four minutes. For a day and-a night it was impossible for Wold Chamberlain Field, a half mile away, to maintain clear radio contact with approaching and departing airliners. And in New Orleans a neighbor's "wireless baby sitter" snarled broadcasting reception up to four miles away.

One should not infer that these are extreme illustrations of RFI. The record of cases grows fatter every day, and such random examples as these are part of it:

- A fly, activating an electric fly-killing device in a restaurant at Logan Airport, Boston, caused the near crash of an Air National Guard plane. Investigation disclosed that the fly killer had broadcast a signal that cut into landing instructions radioed to the plane.
- Another near accident was recorded at a Detroit airport when an arc welder blotted out vital portions of a call from an approaching aircraft.
- When interference plagued radio messages sent by the fire department at East Palestine, Ohio, the offending signal was traced to a radio beacon in Bristol, England. The Kentucky State Police, on the other hand, found its emergency radio communications in a flood area being broken up by a Signal from a Government radio station in Alaska.
- Radiations from an electronic heater in a furniture factory in Martinsville, Virginia, simultaneously disrupted communications at two widely separated points-the Mackay Radio and Telegraph Company in New York City and a secret Federal radio station in Fort Lauderdale Florida.

Case after case could be cited. So numerous are they that the Field Engineering and Monitoring Bureau of the Federal Communications Com- mission, the U.S. agency charged with tracking down RFI, handles only the more serious complaints. The problems of thousands upon thousands of citizens' poor television reception, for example – are generally viewed as not sufficiently grave to merit attention.

To track RFI, the FCC maintains a network of eighteen long-range radio detection stations, as well as mobile and hand detection units in thirty-one field offices. The network enables the agency to take bearings on far-reaching interference as it is refracted from the ionosphere. Two or more bearings are plotted on a map in Washington, D.C., and the intersection of the bearings indicates the general area of RFI. With further bearings, taken and plotted in antenna-equipped cars, local investigators narrow the search still more, until finally, with the aid of listening devices, they can close in on offenders.

When human life is at stake the FCC steps in quickly, and remarkably efficiently for its limited staff, once the hazard has been brought to its attention. The Government, for example, has warned pilots not to rely on certain air-navigation aids in the vicinity of some major cities. It has banned the use of portable FM radios by passengers in all airliners.

After the mid-air collision of two airliners over New York City last December, the Civil Aeronautics Board began investigating the possibility that RFI had made it impossible for the jetliner in the disaster to obtain an accurate radio-navigation bearing, and thus caused it to stray from its assigned path. Shortly after the investigation started, the FCC enforcement chief in New York, acting under new, sweeping powers conferred by the commission, ordered five factories in the metropolitan area to halt at once the operation of electronic equipment that was radiating excessively on frequencies used by air-navigation beacons. The factories were forced to shut down. It so happens that the approach area used by the colliding planes is a hotbed of Radio Frequency Interference from electronic heaters in nearby industrial plants. No one has proved beyond a doubt that RFI caused the collision, but the suspicion lingers, as it does in many an air disaster.

The simple fact is that every piece of electrical equipment is a potential source of interference to other equipment. But cluttered as the atmosphere is with electrical transmissions and bad as the interference between them is, it is bound to become worse. New sources of Radio Frequency Interference are being created daily. The armed services of the United States now depend heavily on electronic equipment, not only to gather and collate intelligence about possible foes but also to make command decisions. Soon a combination of radar and computers will take over from humans, to a large extent, the control of all civilian traffic along the nation's airways. In ten years, an official of the Westinghouse Electric Corporation confidently predicts, computers and related electronic data-processing equipment should be in universal commercial use, even by the store on the corner.

Electronics specialists are worried. "The art of interference control is a tricky one, and new tricks are appearing every day," says Rexford Daniels, head of a crusading civilian group,

Interference Consultants, Inc., of Boston. Writing in an engineers' publication, the IRE Student Quarterly, he gives examples.

A technician puts too sharp a bend in a hook-up wire, and he has made an antenna; an engineer plugs in a power cord and finds that he has created a "ground loop"; a test man leaves a piece of wire lying on a bench and finds that it is resonating; a windstorm blows a copper flashing loose, and it becomes a relay station. When you get fooling around in the microvolt areas, even the change in your pocket can upset readings …. Comparatively few people know, or care, about this growing menace except those who wonder when a plane will crash, a ship will be lost or a guided missile will land in a crowded city.

Is Daniels exaggerating? At Cape Canaveral, Florida, at least one missile – an early Matador type, since redesigned – maneuvered erratically when a woman taxi dispatcher in Austin, Texas, radioed instructions to a driver. The dispatcher's voice, which the Matador picked up, was identical in pitch to the radio signal used to guide the missile. Nearly one in every five launchings at the Cape is delayed in the countdown stage by interference to data-transmission channels from a variety of sources.

"In spite of elaborate precautionary measures taken to prevent interference from occurring," Richard E. Jones, area-frequency co-ordinator of the Atlantic Missile Range, told a recent conference of electronics engineers, "cases still arise which are serious enough to threaten the success of an entire launching operation. When interference does occur, it usually happens at the worst possible time and is not usually recognized as interference at the outset, but as equipment malfunction."

An Air Force specialist, Col. James D. Flashman, chief of frequency allocation in the Directorate of Communications-Electronics, has commented bluntly in Signal, the official journal of the Armed Forces Communications and Electronics Association: "Under concepts by which the frequency spectrum is now used, it is just not possible to guarantee that any portion of the spectrum will be interference free, regardless of national or international intentions or agreements. Controls which would make this guarantee possible simply do not exist. Internationally recognized distress frequencies are probably among the most sacred assignments known; yet these frequencies are seriously abused, not just occasionally but continuously, as mounting reports readily disclose."

Compounding the problem of RFI are the formidable twins of electronic progress – power and speed. The power of equipment – radar in particular – has increased tremendously in recent years. Military radar is now so strong that it can actually cook a man exposed excessively to its rays. The more powerful the equipment, the more likely it is to interfere with other equipment. At the same time the speed of transmitting electrical impulses has increased fantastically. Computers now transmit data at the rate of hundreds of thousands of "bits," or segments, every second. A few seconds' interruption can be ruinous.

Where can the blame for Radio Frequency Interference be placed? One knowledgeable electronics engineer, who prefers to remain anonymous, speaks of ignorance among designers and manufacturers of electronic devices. "If the people who design the equipment know the problem, the problem no longer exists," he contends. "They would adopt methods to control interference, if they knew the peril in their uncontrolled equipment."

For years this engineer has been in the forefront of a small battle being waged by a professional group, the Institute of Radio Engineers, to educate other engineers to the seriousness of RFI and the need to control it, in designing equipment, before manufacturing begins.

So far as military equipment is concerned, any impartial analysis would have to lay part of the blame for RFI at the door of the armed forces themselves. Since World War II – and in some branches even before – the American military has been aware of the growing threat of Radio Frequency Interference. An impressive catalogue of military directives and specifications has been drawn up over the years, aimed at ensuring that new equipment built for the armed forces

would not create new problems of RH. But what has appeared an enlightened solution on paper has proved an added menace in practice.

The military has largely ignored its own careful standards for controlling RFI. More than half of its orders for new equipment, according to one informed military estimate, have been accompanied by waivers to manufacturers, permitting them to side-step rigid anti-RFI specifications.

In some cases such waivers have been the result of honest attempts to meet a nightmarish dilemma. Weakened by rapid demobilization after World War II the services have been working hard to prepare for a possible World War Ill. New equipment has been needed fast. Anti-RFI measures can add time and expense to the development of equipment. The armed forces have tried in some cases to weigh the risk of increasing RFI against the risk of being caught shy of modern equipment in a sneak attack by an enemy, but in the end they have ordered the equipment and waived the anti- RFI specifications. The fact that such equipment might ultimately not work accurately in combat because of RFI hasn't made the choice any easier. More than one defense commander has spent a sleepless night worrying whether RFI might paralyze his equipment before it ever goes into action.

Last year Maj. Gen. Robert J. Wood of the Army Research and Development Office, noting that• the modern battlefield Was "overrun" with electronic devices, asked the House Defense Appropriations Subcommittee to authorize a two-year $8,700,000 study program to find out what would happen if 20,000 such gadgets were operating at once under war conditions. He feared the result would be a hopeless snarl of the airwaves, with devices jamming one another. The study is now under way at the U.S. Army Electronic Proving Ground at Fort Huachuca, Arizona, and yielding important data.

Concern over the effectiveness of military equipment has finally prompted the Defense Department to unite the individual efforts of the Army, Navy and Air Force in the first comprehensive assault on RFI. Last year Deputy Secretary of Defense James H. Douglas told the secretaries of the three military branches in a message: "The increasing use of the radio-frequency spectrum and greater reliance on radiating devices for military purposes is resulting in a Radio Frequency Interference problem that is of great concern." He outlined a Radio Frequency Compatibility Program and ordered it into action at once.

The program is an enormously ambitious attempt to "fingerprint" every type of electronic equipment owned by the military – to determine all the energy radiations of the equipment and to analyze these radiations for potential interference with other equipment. The data – "spectrum signatures," the military calls them – are to be stored in a central library for use in predicting RFI at a given military site.

An analysis center is now being set up at Annapolis, Maryland, under the direction of civilian RFI experts from the Armour Research Foundation of Chicago. In full operation, the center will reduce all the radiation information on military equipment to mathematical equations. Electrical energy in the environment – from all civilian sources, as well as possible jamming that an enemy might introduce – is also to be estimated mathematically. Then computers at the analysis center are to tell how the equipment will perform in combat. Finally this information is to be tested in the field.

The military is hopeful about the compatibility program, possibly more hopeful than it has been about RFI at any time in the past. Where the computers detect interference, the armed forces hope to outflank it through such means as time-sharing of present equipment – permitting the use of equipment only at specified intervals – and alteration of the design of future equipment. But no responsible official is kidding himself into thinking that RFI has yet been contained. The obstacles to even partial success of the compatibility program are great

For one thing, if frequency conflicts arise between civilian and military equipment, which get: the priority? Traditionally the civilian has tender to prevail in peacetime. Another obstacle is the vast ignorance about the nature of RFI. "We don't know enough about radio frequency propagations about what to put into the analysis center's computer," a defense co-ordinator

admits. "It's pretty hard to form an equation that describes the effect on equipment of, say, an airplane passing over head or a truck roaring by." (The airplane's radio and other electrical equipment and the truck's ignition system can create RFI.)

A third roadblock is the massiveness and complexity of the task itself. Getting spectrum signatures for every type of equipment, for example will require thousands upon thousands of man hours. Some experts estimate this task could take as long as three years, unless more funds and technicians are made available.

Meanwhile on the civilian front the war against RFI hobbles along aimlessly, if indeed it can be said to be moving at all. The FCC's Field Engineering and Monitoring Bureau, the police department of the airways, is hopelessly ill equipped to cope with the magnitude of the threat. In all the fifty states the bureau has a total staff of only 381 to handle complaints, track interference, license amateurs, aid ships and planes in distress and serve the public in other ways. Of the 380 staffers only about fifty are assigned specifically to investigate violations. And only half of the work of these fifty is concerned explicitly with curbing RFI.

But even if the FCC's police force was increased fivefold or sixfold – and it could easily use the extra manpower – the agency could never solve the problem of RFI. It simply lacks the power to proceed effectively. It is a stopgap and not a solution. It is authorized to crack down only after RFI has occurred, after the damage has been done. Even then it is frequently strapped by a jack of legal authority unless specific danger to life or property can be proved. Often it must wheedle, humor, even shame offenders into eliminating interference by using shielding or otherwise modifying their equipment.

What is needed – and sorely – is a coordinated civilian-military program to control an RFI. Prevention calls for laws to force the designers of all electric and electronic equipment to make sure their products don't release energy that will interfere with other equipment. Such laws will require that the products meet authorized standards of performance before they can be sold. Just as cities such as Los Angeles have been forced to demand action from the automobile industry and others to control pollution of the air that is breathed, so the Government will have to insist that manufacturers not pollute the electro-magnetic spectrum with unwanted radiations.

Programs that approach this goal are being carried out today in Europe. Great Britain, Germany, Sweden, Norway, Switzerland and the Soviet Union, for instance, have strict laws governing the amount of unwanted energy that electric and electronic devices – even the ignition systems of motor scooters – can emit before they reach the customer. Canada, too, has exacting laws.

Thus far, however, Congress has resisted, as an intrusion on trade, attempts to legislate control over the design of electrical equipment in the United States. The person who uses the product – not the manufacturer – is held responsible for its performance. The Federal Government has no compunction about insisting on safety checks on an airliner before it is allowed in the sky, but it will not lift a finger to monitor the design of electrical equipment that may one day cause the accidental crash of the aircraft.

From the standpoint of national defense, one thing is certain: The problem of RFI must be approached with a greater sense of urgency. A visitor concerned with RPI was talking recently to a responsible Army officer in the Pentagon. "Let me ask you this," the visitor said. "If World War III broke out tomorrow, would this country be in bad shape with respect to Radio Frequency Interference?"

"We'd be in serious trouble," the officer replied. Tradition dies hard, and the tradition of maximum free enterprise and civilian dominance over the military has proved sound in this country since its adoption by the founding fathers. But worried electronics experts are questioning whether tradition should not have some give to it." As they see it, the alternative to some legal control of RFI promptly is drastic legal control eventually – dictatorial rule by the Federal Government of all electric and electronic energy. This step might be necessary, some specialists have suggested, on days on which particularly vital space missions are scheduled or during international crises.

Though few laymen are aware of it, the machinery for such total control already exists, embodied in Public Law 200, enacted in 1951. This law empowers the President, upon proclamation "that there exists war or a threat of war, or a state of public peril or disaster or other national emergency, "to "cause the closing of any station for radio communications, or any device capable of emitting electromagnetic radiations between 10 kilocycles and 100,000 megacycles" – more than 99.9 per cent of all electrical equipment built today. Public Law 200 could be invoked by a proclamation that RFI is a "public peril."

Not long ago a musician was strumming his electric guitar when it suddenly broadcast a message from a passing airplane. One newspaper headlined its report HIS GUITAR TALKS BACK! It was RFI, of course, that was doing the talking, and those who know most about the RFI menace think it's time we all got the message.

(Taken from "EMC Society History" by Dan Hoolihan, in the IEEE EMC Society Newsletter, Winter 2010, pages 32-39, in which Dan describes tracking down the author of "RFI: Invisible Killer", Richard Hatch, which was originally published in the Saturday Evening Post in 1961, http://ewh.ieee.org/soc/emcs/acstrial/newsletters/winter10/RFI.pdf.).

644) Power supply RFI "flat earthers"

Patrick Andre, of Andre Consulting, Inc., found out what is was like to face a group of engineers who thought the Earth was flat or at least that power supplies couldn't possibly radiate at 230MHz. As usual, the story is told from the teller's perspective.

"One day I was called in by a Washington State medical instrumentation company to assist in finding the source of emissions. When I arrived I was informed that if in the next week or so, I could find the problem they were having during radiated emissions, it would save them a great deal of money. The radiated emissions were out of specification by at least 10dB at 230MHz, and about 5dB at 180MHz. They were already into a production hold, a schedule slide, and looking at circuit board turns and software changes.

I was led into a room where I met about 10 people who were involved with the problem. They included engineers flown in from the east coast, various consultants and contractors, staff engineers, and technicians. I was presented with enormous, stacks of test data, schematics, drawings, and the like. The whole thing was overwhelming. After listening to a barrage of confusing and conflicting data, I asked them if we could just go down to their EMI laboratory to see what might be going on.

I found the unit to be a roll around rack, six feet high, four feet wide, four feet deep, made up of stainless steel racks, each with filtered connectors, properly terminated coax, and high quality EMI gaskets on the lid. The lid was held down with thousands of screws, maybe more. After the lid was finally removed, the inside contained a well-designed circuit board, carefully routed cabling, and the addition of several pounds of clip on ferrites. The thing was bulletproof.

It was about this time I found out one key piece of information. The emissions only occurred when the "incubation heater" was energized. I asked where the power to the incubation circuit came from. I was shown the place on the circuit board where it was routed, and how it came from this connector on this back corner. So I asked, "The power for the incubation circuit comes from off the board?" "Oh yes", I was told, "It comes from this power supply. Mounted up here." And there sat a power supply on the top of the rack of equipment.

I asked if we could change that power supply for a linear power supply. The room fell silent. I got stares from the small crowd watching me as if I had two noses. I heard someone question my general value to the project for thinking a power supply could generate 230MHz. I said, "Humor me. Get a linear power supply and let us eliminate it as a possibility." The technician brought back a nice HP power supply, placed it in circuit and we turned on the unit. From 150MHz and higher, emissions dropped 50dB – to the noise floor of the spectrum analyzer. I spent the next hour slowly removing the several pounds of added ferrite before calling it a day."

(Taken from "Don't Be Silly . . . It Can't Be That!" by Todd Robinson, Associate Editor, in the "Chapter Chatter" section of the IEEE EMC Society newsletter, Issue 218, Summer 2008, page 10, http://www.emcs.org.)

645) Emissions limits do not protect built-in radio receivers

It has been known for some time that signals running on the LCD panel in a notebook can create EMI. This EMI not only can be an issue for FCC compliance, it also poses an even greater problem for wireless devices that are now being put in notebooks.

Some of this noise comes from video data, but some of the most serious levels of noise come from clock signals (namely pixel clock) whose harmonics can fall into radio bands. Below is an illustration of such an example. Here the 65MHz pixel clock on a commercially available notebook is causing harmonics (37th and 38th) to be generated that fall into the wireless 802.11b, g band.

Generally, the level of emissions is controlled only to the extent needed to pass FCC unintentional (part 15) emissions. However, to satisfy radio requirements, the level of interference needs to be much lower.

Figure 1 below is an example of the noise taken from a laptop with the FCC limits and wireless requirements shown. Typically, a gap of more than 45dB exists between these limits. The present FCC limits obviously are not sufficient to protect built-in radios unless manufacturers address the real radio requirements for EMI.

(Taken from "A Study of Platform EMI from LCD Panels – Impact on Wireless, Root Causes and Mitigation Methods", by Jin Shi, Al Bettner and Gordon Chinn, Mobile Platforms Group, Intel Corporation, Santa Clara, CA, 95054, Kevin Slattery and Xiaopeng Dong, Corporate Technology Group, Intel Corporation, Hillsboro, OR 97124, International Symposium on EMC, Portland, OR, USA, 14-18 Aug 2006, www.emcs.org.)

646) The battle for the airwaves

Battles of the airwaves are fought by network operators locating sources of interference, regulators countering pirate radio, and the armed forces hunting out signals from terrorists. All use radio monitoring in the field.

Private radio stations account for the majority of illegal broadcasts. They tend to operate within cities, generally on the FM radio frequencies of 87.5 to l08MHz. But interference also arises from other causes: poorly installed wireless LANS, older CB equipment and amateur radio, badly suppressed electrical equipment, or even faulty lightbulbs or thermostats.

Regulators (such as Ofcom) police radio spectrum by pinpointing sources of interfering radio signals. While interference takes many forms, regulatory authorities have a duty to act when it is caused with intent, particularly if it causes interference with the safety critical air traffic and marine bands.

Meanwhile, network operators are waging their own battle with radio interference. In response to problems such as poor voice quality; dropped calls or low data rates, network operators employ field engineers to track down and eliminate the interference. Faulty network equipment is a major source of the problem.

Interference is also more prevalent nowadays because network operators continually add voice and data services, so the licensed bands become more susceptible to it. The trend to install multiple basestations on each site has also increased interference potential.

(Taken from "The Signal Hunters", by John Andrews, IET Engineering & Technology magazine, 5 Jul – 18 Jul 2008, page 78, www.theiet.org/engtechmag)

647) Satellite broadband service delayed by interference to GPS

Until LightSquared comes up with a plan that completely protects existing GPS navigation devices from interference, LightSquared cannot operate its satellite-based broadband service.

*(Taken from "**GNSS System Congressional Committee Blocks FCC Approval of LightSquared**", GPS World, June 27, 2011, http://www.gpsworld.com/gnss-system/news/congressional-committee-blocks-fcc-approval-lightsquared-11818, reported by Interference Technology magazine on 29th June 2011, at www.interferencetechnology.com/lead-news/article/congressional-committee-blocks-fcc-approval-of-lightsquared.html.)*

648) Doomsday Plane's Immunity to Electromagnetic Pulse Determined via RS105 Testing

Metlabs admin, June 23, 2011, file under EMC, Military

With the recent news that the U.S. President's $223 million "doomsday plane" is protected from electromagnetic pulse (EMP) came the inevitable questions. What is EMP and how is it created? How can a plane with a reported 165,000 pounds of state-of-the-art electronics possibly be protected from such a sinister attack?

(The ABC News video at www.youtube.com/watch?v=FJF3Og9cCp8&feature=youtu.be shows an interesting guided tour of the President's plane, which is called "Nightwatch", and in addition to being shielded against EM Pulse also has thermal and radiation shielding to help protect it from nuclear bombs – Editor.)

EMP & Its Creation

EMP is a high amplitude, short duration, broadband pulse of electromagnetic energy which can have devastating effects on unprotected electronic equipment and systems.

The electromagnetic pulse effect was first observed during the early testing of high altitude airburst nuclear weapons. During the explosion, gamma rays (high energy photons) are rapidly released in all directions from the blast. These gamma rays interact with air molecules in the earth's atmosphere, which creates electromagnetic energy. This interaction process is called the "Compton Effect."

Energy of these pulses disperse across a broad spectrum, but the majority of pulse energy resides in the frequency spectrum of 10MHz-100MHz. For a large quantity of electronic equipment, this is the operating range and hence the greatest risk. Peak field strengths are estimated to reach into thousands of volts.

Non-nuclear EMP technologies – called "Directed Energy Weapons" – are increasingly being developed. They are capable of graduated effects on electronics ranging from disrupting operation, to permanent damage, and complete destruction. These weapons include:

- Arc Discharge EMP Generator
- Flux Compression Generator (FCG)

EMP Immunity Testing

The RS105 test method specified in MIL-STD-461F addresses the risk of radiated exposure to an EMP event. The U.S. Navy, among other military branches, requires RS105 testing for nearly every installation platform, from surface ships, submarines, and aircraft, to ground applications.

The test follows this procedure:

- Start at 10% of specified level
- Verify waveform
- Apply pulse 5 times at the rate of not more than 1 pulse per minute
- Rotate equipment under test (EUT) 90 degrees, and pulse 5 more times
- Rotate another 90 degrees and pulse 5 times
- Monitor for signs of degradation

The purpose of RS105 testing is not to damage the equipment, but to determine its immunity threshold to the electromagnetic pulse.

Hollywood's Take on EMP

Last, and most important, was the EMP attack, or "pinch," featured in the 2001 movie Ocean's Eleven possible? If you remember, George Clooney and his fellow con artists utilize a "Z-pinch" that detonates an intense electromagnetic pulse that blacks out Las Vegas' entire power grid for a few moments (in order for them to sneak into a casino vault).

No, says Sandia National Laboratories, owner of the world's most powerful Z-pinch. The super-charged electrical generator creates a rainbow spectrum of intense x-rays, but a feeble EMP.

Read more about RS105 and other military electromagnetic compatibility (EMC) tests: http://www.metlabs.com/Industries/Military/Military-EMC-Testing.aspx

Watch a 39-minute recorded webinar on RS105 testing: http://www.youtube.com/watch?v=T3OWjjDNIe0&feature=youtu.be

(Taken from Metlabs' article with the same title, at www.interferencetechnology.com/lead-news/article/doomsday-planes-immunity-to-electromagnetic-pulse-determined-via-rs105-testing.html. Also reported by Interference Technology magazine on 29th June 2011, at www.interferencetechnology.com/lead-news/article/doomsday-planes-immunity-to-electromagnetic-pulse-determined-via-rs105-testing.html.)

649) Confidential report reveals 75 Incidences of EMI on planes

Like most airline passengers, you probably have serious doubts about those pre-flight announcements asking you to turn off your cellphones, blackberries, iPods and anything else electronic.

The announcements are flat-out ignored by many frequent fliers, who are skeptical that so-called "personal electronic devices" pose any safety threat to airplane. Some passengers openly rebel, like New York Sen. Chuck Schumer, who cursed out one flight attendant who demanded he turn off his cellphone.

But a confidential industry study obtained by ABC News indicates there really could be serious safety issues related to cellphones and other PEDs.

A report by the International Air Transport Association, a trade group representing more 230 passenger and cargo airlines worldwide, documents 75 separate incidents of possible electronic interference that airline pilots and other crew members believed were linked to mobile phones and other electronic devices. The report covers the years 2003 to 2009 and is based on survey responses from 125 airlines that account for a quarter of the world's air traffic.

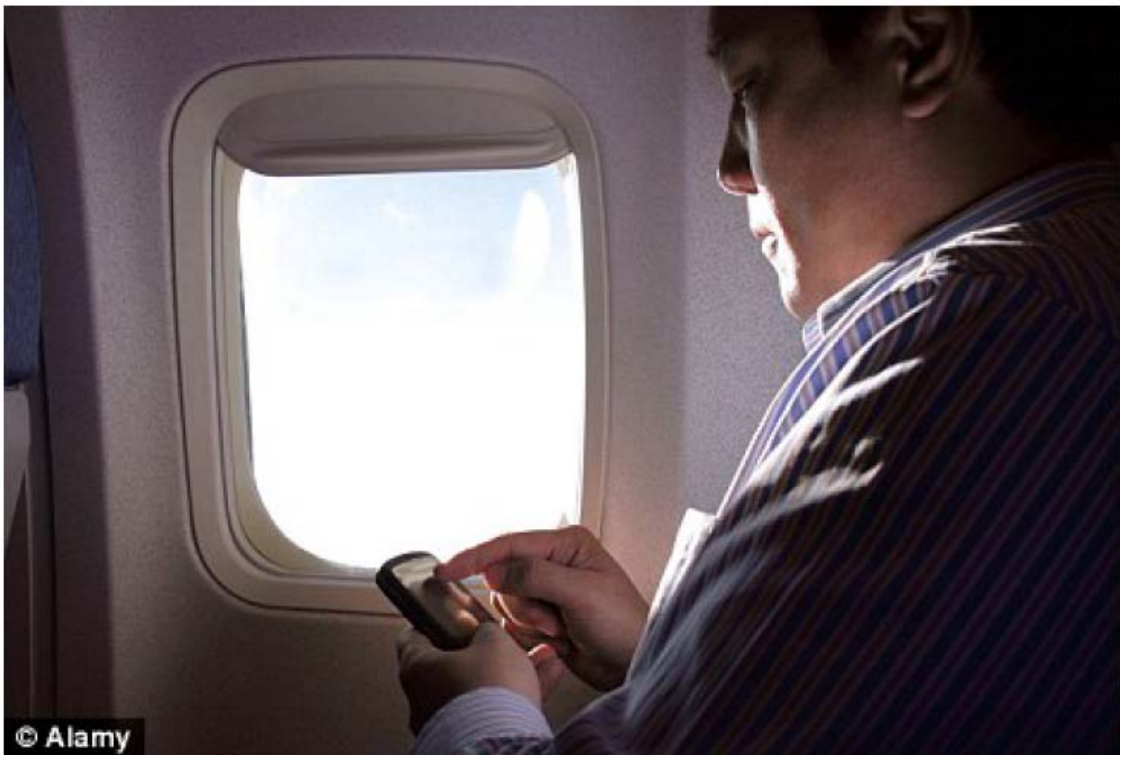


Photo: A businessman uses his mobile whilst in flight
(from the Daily Mail article referenced below)

Twenty-six of the incidents in the report affected the flight controls, including the autopilot, autothrust and landing gear. Seventeen affected navigation systems, while 15 affected communication systems. Thirteen of the incidents produced electronic warnings, including "engine indications." The type of personal device most often suspected in the incidents were cell phones, linked to four out of ten.

The report, which stresses that it is not verifying that the incidents were caused by PEDs, includes a sampling of the narratives provided by pilots and crewmembers who believed they were experiencing electronic interference.

"Auto pilot was engaged," reads one. "At about 4500 ft, the autopilot disengaged by itself and the associated warnings/indications came on. [Flight attendants] were immediately advised to look out for PAX [passengers] operating electronic devices. ... [Attendants] reported that there were 4 PAX operated electronic devices (1 handphone and 3 iPods)." The crew used the public address system to advise the passengers to shut off electronic devices "for their safety and the safety of the flight," after which the aircraft proceeded "without any further incident."

In other events described in the report, a clock spun backwards and a GPS in cabin read incorrectly while two laptops were being used nearby. During another flight, the altitude control readings changed rapidly until a crew member asked passengers to turn off their electronic devices. The readings returned to normal. "After an hour, changes were noticed again . . . Purser made a second announcement and the phenomena stopped."

Dave Carson of Boeing, the co-chair of a federal advisory committee that investigated the problem of electronic interference from portable devices, says that PEDs radiate signals that can hit and disrupt highly sensitive electronic sensors hidden in the plane's passenger area, including those for an instrument landing system used in bad weather.

"It could be you that you were to the right of the runway when in fact, you were to the left of the runway," said Carson, "or just completely wipe out the signal so that you didn't get any indication of where you are coming in."

Asked if a cellphone's signal could really be that powerful, Carson said, "It is when it goes in the right place at the right time."

To prove his point, Carson took ABC News inside Boeing's electronic test chamber in Seattle, where engineers demonstrated the hidden signals from several electronic devices that were well over what Boeing considers the acceptable limit for aircraft equipment. A Blackberry and an iPhone were both over the limit, but the worst offender was an iPad. There are still doubters, including ABC News's own aviation expert, John Nance.

"There is a lot of anecdotal evidence out there, but it's not evidence at all," said Nance, a former Air Force and commercial pilot. "It's pilots, like myself, who thought they saw something but they couldn't pin it to anything in particular. And those stories are not rampant enough, considering 32,000 flights a day over the U.S., to be convincing."

Nance thinks there are alternate explanations for the events. "If an airplane is properly hardened, in terms of the sheathing of the electronics, there's no way interference can occur."

But Boeing engineers told us that signals from PEDs could disrupt the navigation and communication frequencies on older planes, which are not as well shielded as the newer models. And anything that distracts the pilots in the cockpit is considered a true threat to safety.

*(Taken from: "**Is It Really Safe to Use a Cellphone on a Plane?**", by Brian Ross and Avni Patel, of ABC News, June 9, 2011, at: http://abcnews.go.com/Blotter/safe-cellphone-plane/story?id=13791569, kindly sent in by Doug Hughes ("The EMI Detective").*

Doug recommends viewing the actual broadcast, at: http://abcnews.go.com/WNT/video/cellphone-use-on-planes-safety-threat-13806022, and says that http://abcnews.go.com/GMA/video/danger-cell-phones-takeoff-landing-13799400 is also relevant. It is worth putting up with the introductory commercials, to see the videos of the very high levels of radiated emissions from certain very well-known types of passenger electronic devices (PEDs).

This ABC news item was also reported by Interference Technology magazine on 15th June 2011 at www.interferencetechnology.com/lead-news/article/report-unveils-75-incidences-of-electronic-interference-on-planes.html.

The Daily Mail newspaper had their own take on this confidential report in their article "How just ONE mobile phone can make a plane crash, leaked study reveals", by Daniel Bates, published on the 10th June 2011, see: www.dailymail.co.uk/news/article-2001926/Your-mobile-phone-REALLY-makeplanes-crash-leaked-air-transport-study-reveals.html, which was kindly sent in by frequent contributor to Banana Skins Robert Higginson, trebornosniggih@gmail.com, on 10th June 2011)

650) Solar storms threaten national grids, controlled power cuts likely

Officials in Britain and the United States are preparing to make controlled power cuts to their national electricity supplies in response to a warning of a possible powerful solar storm hitting the Earth. In an interview with The Independent, Thomas Bogdan, director of the US Space Weather Prediction Centre, said that controlled power "outages" will protect the National Electricity Grids against damage which could take months or even years to repair should a large solar storm collide with the Earth without any precautions being taken.

Dr Bogdan is in close discussions with scientists in the UK Met Office to set up a second space weather prediction centre in Britain to co-ordinate a global response to a threat viewed seriously by both the US and UK governments. One topic of discussion is how to protect national electricity grids from the immense power surges caused by the geomagnetic storms which happen when highly energetic solar particles collide with the Earth's magnetic field.

The most vulnerable parts of the grid are the hundreds of transformers connected to power lines many miles long that can experience sudden current surges during a geomagnetic solar storm, Dr Bogdan said. "It points to a potential scenario where large parts of either North America or northern Europe may be without power from between days or weeks, to perhaps months and, in extreme cases, there are estimates that it could last years," Dr Bogdan said.

The aim of the joint US-UK collaboration is to improve solar weather forecasting to a point where it is possible to warn power companies of an imminent storm. There is a feeling that if a "category 5" solar storm – the biggest of the five categories – were to be predicted, then taking the grid off-line before it is due to hit Earth and letting the storm pass would be better than trying to keep things running, he said.

In 1989, a solar geomagnetic storm knocked out the electricity grid across large parts of Canada. The loss cascaded across the United States and caused power problems as far away as California. The greatest fear is a massive storm as big as the one documented by astronomer Richard Carrington in 1859, which burnt out telegraph wires.

"The sort of storms capable of doing that are fairly rare events. We refer to them as 'black swans'," Dr Bogdan said. "If the Carrington event occurred today, and power grid operators did not take efforts to safeguard their infrastructure, then we could be facing a scenario like that."

(Taken from: "'Controlled' power cuts likely as Sun storm threatens national grid" by Steve Connor, Science Editor of The Independent, in Boulder, Colorado, www.Independent.co.uk, Monday, 13 June 2011. Kindly sent in Dr Antony Anderson, also on 13 June 2011.)

651) Walkie-Talkie Shuts Nuke Plant Safety System

The Davis-Besse nuclear power plant near Toledo, OH, lost the entire emergency shutdown system all because of a walkie talkie.

The scenario goes like this: A technician at the power plant used his walkie talkie in a room containing a back-up or auxiliary control panel for a system designed to automatically pump water into the reactor in the event of a catastrophic accident.

The radio wave disrupted the signal from the control panel to special pumps and emergency valves that even on stand-by are electrically alive for an instantaneous reaction.

In two bursts of conversation lasting 8 seconds and 19 seconds during a two-minute period, the technician rendered the plant's entire emergency shutdown system inoperable, the company told federal regulators.

The company posted a sign on the door to the room warning all employees not to key their radios near the sensitive control panel, said Todd Schneider, company spokesman.

The incident should have never happened, said David Lochbaum, nuclear safety engineer with the Union of Concerned Scientists. He said such incidents occurred a number of times in the early 1980s, so much that the Nuclear Regulatory Commission issued a warning bulletin in December 1983.

"This hasn't happened in decades," Lochbaum said. "Davis-Besse was warned but has failed to heed the warning."

The NRC wants to talk to that worker, said Victoria Mitlyng, spokeswoman for the NRC's regional office in Chicago. "We will definitely be looking into this."

(Taken from a LinkedIn posting with the same title, by G Hale on March 9, 2011.)

652) EM pulse causes railcar EMI problems

During a recent Connecticut Rail Commuter Council forum, it was revealed that hardware problems contributed to an electromagnetic pulse that caused propulsion systems on the state's new M-8 rail cars to set off track signals. The final testing hurdle is a series of simulated passenger runs in which the cars must run without substantial error for 4,000 miles. The first train of six M-8 cars will make its inaugural run carrying paying customers within weeks.

Photograph: One of the Metro-North Railroad's eight new M-8 railcars.

Photo: ST, Contributed Photo / Stamford Advocate Contributed.

(Taken from "Electronic pulse causes railcar problems", by IFI, www.ifi.com/web/html/articles/article0411_02.htm, 30 Mar 2011.)

653) Northern lights blight satnav

Motorists have come to rely on their sat nav to get them from A to B. Unfortunately, interference from the aurora borealis, or northern lights, can degrade the quality of the GPS signal, making sat navs less accurate, say researchers at Lancaster University. They have created a live AuroraWatch website at tinyurl.com/n7ssx that will email you warnings of any suspect auroral activity. Your sat nav is likely to be affected only if near the Earth's magnetic poles or in about five years' time when we reach the peak of the solar cycle.

(Taken from "Northern Blight", The Sunday Times, 13 July 2008, www.timesonloine.co.uk/ingear)

654) Microwave cookers blight Wi-Fi

For example, this could be used for microwave ovens, which frequently impair WLAN communications in the frequency range from 2400MHz to 2500MHz.

(Taken from "Accurate Detection of Impulsive Electromagnetic Disturbance" by Jens Medler and Matthias Keller, Rhode & Schwarz GmbH, The EMC Journal, July 2008, page 27, www.theemcjournal.com)

655) Surge overvoltages blight industrial electronics

A recent study by a European insurance company found that, of the 77,000 items of industrial electronics evaluated, the most common cause of failure was surge overvoltage. Surge

damage contributed to 28% of failures, while the next most significant category, lack of maintenance, contributed to 25% of claims.

(Taken from "Are you doing enough to protect your assets?", by MTL Surge Technologies, in Electrical Engineering, March 2008, page 27, www.connectingindustry.com/story.asp?storycode=184484)

656) Scooters blight digital TV

When I watch digital TV channels from terrestrial transmitters, I have to endure periodic disruptions during which the audio and images start stuttering. I recently realised that the disturbance occur every time motorbikes – particularly scooters – pass my house. It doesn't happen with cars. How do scooters disrupt my TV?

(A question by Michael Smith, posed in "The last word", New Scientist, 22 October 2008, http://www.newscientist.com/blog/lastword/2008/04/on-blink.html)

OOPS – this is a partial repeat of #521

657) Dissimilar metals blight shielding

Here's a historical example from your author's experience. Years ago, imported personal computers sometimes used zinc finished sheet metal chassis connected to a cover of similar material with beryllium copper spring fingers.

These materials are far apart on the galvanic scale. After a fairly short time – days to weeks – the shielding performance deteriorated noticeably, and higher radiated emissions would be seen. Upon disassembly, a fine dark line of corrosion could be seen at the contact between the materials.

The zinc, being less noble than the spring finger material, would corrode. In addition, the contact area was minimal, consisting of a line where the fingers curved against the case. When the case was flexed, or if it were disassembled and the surface cleaned, the shielding effectiveness would return to its original level.

(Taken from "EMC Design for Compliance – Enclosures", by the Editors of Conformity, in Conformity magazine's 2008 Annual Guide, www.conformity.com)

658) Pelican crossing blights pre-payment card's cash

Consider the case of Mrs Shirley Jones. Who lives in Cannock, in Staffordshire. She has a pre-payment meter for her domestic electricity usage. Her supplier is RWE, who own N-power.

Each week Mrs Jones puts credit into her top-up card at the local shop.

One week she changed the shop she goes to. To get back home from the store, she needed to use a pelican crossing. When she got home, and slotted it into her meter, she found that her card had absolutely no credit on it. Which it most certainly did have, even before she topped up the overall amount at the shop.

"I thought that was a bit weird. So I went back to the shop. They confirmed that the money had definitely been put onto my N-Power card", said a puzzled Mrs Jones. "We went through all the possible causes of my card having been wiped, and eventually the manager discovered the culprit. It was the pelican crossing I had walked past on my back from the shop. Apparently the electronic beeps in the pelican crossings have the capacity to wipe these top-up cards, simply by you walking past them with the card in your hand," she concluded.

I gather that on this occasion RWE did in due course refund the money. But it does make me wonder just how many other poorer households are being surcharged in this curious way? I do not know. But I think we should be told.

(Taken from "Wiped out by a Pelican crossing", in the "opinion" section on page 10 of Electrical Review, May 2008. For readers who are not familiar with the UK's Pelican crossings, please visit http://en.wikipedia.org/wiki/Pelican_crossing. We know that we don't have EMC standards that actually ensure EMC, but it becomes a bit more than annoying when EMI wipes out our electronic cash! – Editor.)

659) LED lamps blight DAB radio reception

I just switched on all my LED MR16 lamps, and found that one of my neighbours (the other one doesn't have DAB) had no reception. I then switched them all off again, and DAB reception in his house was fine again.

(From an email correspondence with the Editor, 5th September 2011. The author lives in the UK and wishes to remain anonymous.)

660) Harmonic distortion blights plant equipment

Harmonic distortion can cause untold damage to plant equipment. But this problem can be solved using frequency converters, as in the case of a nickel plant that uses low harmonic drives from ABB.

On three separate occasions, over a two-year period, Pertti Sihvonen experienced unexplained damage to equipment on his nickel production line.

On each occasion the equipment damage was confined to a 690V system that was being fed by a 3.15MVA transformer at OMG Harjavalta Nickel Oy's production plant in Finland. Over 2MW of the load on this system is controlled by frequency converters and Sihvonen had his suspicions that the culprit could be these non-linear loads and variations they were producing in the network power quality.

Sihvonen, OMG's electrical and automation manager, is not the first end user to experience the potentially damaging effects of non-linear loads on a power network.

End users and power companies are increasingly concerned about the phenomenon of harmonics. Harmonic distortion can manifest itself in some serious ways and may disturb or even damage sensitive equipment connected to the same electrical network.

You may not be able to see, smell or hear a harmonic but you can detect its damage by way of excessive heating of conductors, motors or transformers through to spurious tripping of circuit breakers, damage to lighting and interference with communications equipment and even mechanical vibration.

Non-linear loads connected to the network, such as rectifiers and regular motor drives, produce harmonic components in the network current and, via the current in, result in a distorted network voltage.

(Taken from "Using frequency converters to control harmful harmonics", by ABB, www.connectingindustry.com/story.asp?storycode=186878, 23 Sep 2008)

661) Nuclear power plant RF transmitter exclusion zones don't work

However, exclusion zones have in some cases failed to provide the required protection and are becoming increasingly burdensome to establish and enforce. This was the consensus, lead by one lead I&C engineer from a major US utility in the south who is currently designing advanced nuclear plants (with one under construction) at the December 2008 EPRI Nuclear EMI Working Group Meeting held in Washington, DC.

Interference incidents which have occurred give evidence to the failure of the exclusion zone strategy to provide the desired level of EMC protection for I&C systems in existing nuclear plants. There are many documented cases of malfunction and upset of I&C systems in existing plants caused by operation of a portable wireless transmission device (not always a walkie-talkie) too close to a standard system cabinet with its doors closed.

At times, the failure is caused by a source of EM energy that was not recognized as such where an exclusion zone was not involved. One example occurred when the starter for a high intensity discharge (HID) lighting system (magnetically-ballasted) emitted an EM pulse when it attempted to strike a burned out lamp. Because the lamp was burned out, the starter repeatedly attempted to ignite it, emitting a continuing stream of EM pulses as a result. These emissions caused false detections to be registered in a radiation monitor located in another room in the plant. Radiated EM pulses from failed lamps were converted into a band of conducted emissions coupled into the signal loop of the radiation monitoring system. This caused frequent false alarms in the control room.

Another reason for the failure of exclusion zones is that with the increasing use of wireless technology, enforcement of exclusion zones is increasingly problematic. As wireless technologies are adopted and become a more significant part of the work equipment for various personnel, like maintenance workers and security personnel, conflicts are created when enforcement of the exclusion zone would deprive a worker of the tools they rely on to perform their job. This kind of conflict is likely to become increasingly prevalent as wireless technologies are used for an ever increasing variety of functions. Moreover, in today's culture of increased security required to protect nuclear plants and instantly respond to any potential threat, security and plant personnel, any restriction on the use of portable wireless devices will only limit the effectiveness of these personnel to protect the staff and the plant from a possible catastrophic situation. Security personnel must be focused on protecting the plant and staff without having to worry about tripping a critical safety-related I&C system.

The job of an I&C engineer and other plant personnel on the plant floor frequently involves the use of portable wireless devices when the doors of system cabinets are open. Communications are needed with other personnel out in the plant to maintain and troubleshoot I&C systems. Without these communications, standard procedures needed to bring I&C systems back up on line could not be performed.

(Taken from: "Eliminating the need for exclusion zones in nuclear power plants", by Philip F. Keebler, Electric Power Research Institute, In Compliance magazine, June 2011, www.incompliancemag.com/index.php?option=com_content&view=article&id=699:eliminatingthe-need-for-exclusion-zones-in-nuclear-power-plants&catid=26:design&Itemid=130.)

662) Cool Facts about Lightning

Lightning is essentially a gigantic electrical spark that results from billions of volts of natural static electricity. Lightning is usually associated with thunderstorms and rain. Most meteorologists will agree that ice formation in clouds is a key factor for starting the "electric generator" that produces lightning. There are several theories as to how lightning is produced.

It seems the best one so far [called the "Charge Reversal Concept"] requires that falling graupel (small ice pellets) become negatively charged while small supercooled cloud droplets that strike then bounce off the graupel become positively charged. Cloud temperature can affect the "charge sign" of the graupel. If the temperature is below -10C then the graupel takes a negative charge and the supercooled cloud droplets take a positive charge. The supercooled cloud droplets rise on updrafts to the top of the storm while the graupel pellets fall and melt in the lower regions of the storm.

Lightning Safety Facts from NOAA:

- Each second there are 50 to 100 Cloud-to-Ground Lightning Strikes to the Earth world-wide.
- Most lightning strikes average 2 to 3 miles long and carry a current of 10,000 Amps at 100 million Volts.
- A "Positive Giant" is a lightning strike that hits the ground up to 20 miles away from the storm. Because it seems to strike from a clear sky it is known as "A Bolt From The Blue". These "Positive Giant" flashes strike between the storm's top "anvil" and the Earth and carry several times the destructive energy of a "regular" lightning strike.
- Thunder can only be heard about 12 miles away under good quiet outdoor conditions.
- Daytime lightning is difficult or impossible to see under local sun and/or hazy conditions. Night-time "heat lightning" can be seen up to 100 miles away (depending on "seeing" conditions).
- "Lightning Crawlers" or "Spider Lightning" can travel over 35 miles as it "crawls" across the bottoms or through squall line "frontal" clouds. This rare type of lightning is very beautiful as it zaps from "horizon-to-horizon". However it can turn deadly if it happens to strike the ground at the end of its super long path! {Lightning Crawlers from The Blue!}

- Radar has detected Lightning "Crawlers" traveling at high altitudes (15,000 ft to 20,000 ft) as they zap from cloud-to-cloud.
- Lightning "Crawlers" over seventy five (75) miles long have been observed by Radar!
- The temperature of a typical lightning bolt is 5x hotter than the surface of the Sun!
- How big around is a typical lightning bolt? Answer: About the size of a Quarter to Half-Dollar! Lightning looks so much wider than it really is just because its light is so bright!
- Lightning Strikes create powerful radio waves in the frequency range of 3 kHz (audio, VLF) through 10 MHz (shortwave radio). The VLF (3 kHz to 30 MHz) "lightning signatures" can travel around the world, allowing monitoring of world-wide lightning. The shortwave "lightning signatures can travel half-way around the Earth (the night-time side of the Earth). The best region to listen for distant shortwave lightning signatures is from 2 MHz through 7 MHz. After 3 AM local time you can listen to 3 MHz and hear the beautiful dispersion-ringing of the static as it bounces back-and-forth between the earth and ionosphere. It can at times sound like hundreds of tiny bells ringing at once!
- Red Sprite lightning is a newly-discovered type of lightning that zaps between the 40 mile span between the tops of severe storm clouds to the lower ionosphere "D" layer. Red Sprite Lightning looks like a giant "blood-red"-colored jellyfish having light-blue tentacles. Red Sprite Lightning creates extremely powerful radio emissions from 1 kHz through VHF.
- Red Sprite Lightning has been associated with very powerful "Atmospheric Gamma Ray Bursts". Nuclear Radiation from Lightning Strikes!

(Taken from "Cool Facts" by Nextek, www.nexteklightning.com/enews/408/coolfacts.htm 23 May 2008)

663) Opamps with inherent RF immunity

The experiment is performed on two different dual op amps: a typical standard op amp and the LMV832, EMI hardened dual op amp. A cell phone is placed on a fixed position a couple of centimetres from the op amps in the sensor circuit.

When the cell phone is called, the PCB and wiring connected to the op amps receive the RF signal. Subsequently, the op amps detect the RF voltages and current that end up at their pins. The resulting effect on the output of the second op amp is shown in Figure 6.

The difference between the two types of dual op amps is clearly visible. The typical standard dual op amp has an output shift (disturbed signal) larger than 1V as a result of the RF signal transmitted by the cell phone. The LMV832, EMI hardened op amp does not show any significant disturbances. This means that the RF signal will not disturb the signal entering the ADC when using the LMV832.

(Taken from the LMV831 preliminary datasheet dated August 5, 2008, available from www.national.com.)

664) Even the tiniest track of the most carefully designed printed circuit board (PCB) behaves like a microwave transmission line

The growth of electronics, the use of higher frequencies, and the omnipresence of fast computing devices have made electromagnetic compatibility (EMC) a global concern. With electronics working at speeds of a few hundred megahertz to some gigahertz, even the tiniest track of the most carefully designed printed circuit board (PCB) behaves like a microwave transmission line.

Previously, increasing working frequencies extrapolated electromagnetic interference (EMI) problems from long power lines to smaller PCB tracks, and history is repeating itself by moving this issue toward the field of microelectronic circuits. Due to their small size, integrated circuits (ICs) are, in practice, not easily disturbed by radiated disturbances; they are, however, prone to noisy conducted interference.

(Taken from the Introduction section of "An externally trimmed integrated DC current regulator insensitive to conducted EMI" by Jean-Michel Redouté et al, IEEE Trans. EMC, Vol. 50, No. 1, February 2008, page 63.)

665) Kangaroo leather shoes increase ESD from 5kV to 15kV

Dan Hoolihan has been practicing in the EMC arena for more than three decades. The following story falls into the 'strange but true' category that experienced EMC engineers, such as Dan, always have a number of in their files. How would users react today with these kind of operational instructions?

"Back in the 1970s when electrostatic discharge (ESD) and its impact on electronic equipment was first being researched, many companies were experimenting with various ways to test equipment for ESD susceptibility. Since "standard" ESD generators were not available, many companies developed their own generators including small Van de Graaff machines, lab-built generators, and standard nylon carpets.

A low-cost computer terminal (an electronic station designed to allow a person to communicate with a large, highspeed mainframe) was developed by a computer company in the United States. The terminal was successfully designed, tested for conformance to internal corporate specifications, and went into production. The design verification testing included both emission and immunity testing for EMC performance. One of the immunity tests was an ESD test using a "standard" nylon carpet that the tester would shuffle his feet on and measure about 5 kilo volts (with a sensitive electrostatic voltmeter) before discharging himself to the unit under test. The terminal passed the test and was used successfully around the world except in Australia.

In Australia, the terminal had consistent ESD failures. In attempting to trouble-shoot the problem, an engineer from Australia came to the United States and worked with the design engineers. The computer terminal was placed in a large environmental chamber and the relative humidity was lowered to about 10% for a worst-case test of ESD. The engineer from Australia stepped on the "standard" nylon carpet, shuffled his feet and the electrostatic voltmeter measured 15 kilovolts instead of the usual 5 kilovolts, and, of course, when he discharged to the terminal, it failed.

The design engineers were amazed at the amplitude of the voltage and started to quiz the Australian on what he was doing or what clothes he was wearing. He convinced the design engineers he had on "normal" clothing except for his kangaroo leather shoes!

The company had a choice of coming up with a special fix for the product for Australia or outlawing kangaroo leather shoes. They chose to recommend to their Australian customers to preclude the wearing of kangaroo leather shoes if they wanted to avoid ESD problems with the low-cost terminal."

(Taken from "Chapter Chatter – Special ESD Test from Down Under", by Todd Robinson, Associate Editor, IEEE EMC Society Newsletter, Issue 216 "Winter 2008", April 2008, page 10, www.emcs.org/acstrial/newsletters/winter08/chatter.pdf)