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EMI Stories Compendium

Helping you solve your EMC problems

1 Brassey Road, Old Potts Way, Shrewsbury, SY3 7FA T:+44 (0) 1785 660 247 E:info@emcstandards.co.uk

Cherry Clough Consultants Ltd
9 Bracken View, Brocton
Stafford, ST17 0TF, UK
tel: +44 (0)1785 660 247
fax +44 (0)1785 660 247
email: keith.armstrong@cherryclough.com
web: www.cherryclough.com

EMI Stories

A collection of 890 real-life short stories about the dangers of electromagnetic interference (EMI)

Indexed by type of application, type of EMI, and whether safety was an issue, to aid research

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Numbers 1-855 were originally published as 'Banana Skins' in The EMC Journal, www.theemcjournal.com

Some of these stories are extracted from official documents and reports, some are personal anecdotes, and some come from research.

Some of these EMI Stories had harmless or amusing outcomes, some lost companies large amounts of time / money, even causing bankruptcy, and some caused (or could easily have caused) injuries and deaths.

My experience is that these stories only represent the very tip of a large iceberg, with unguessable costs for manufacturers and society as a whole. As electronic devices and technologies continue to advance; more (and more complex) software and wireless communications are used; as electronic systems are increasingly integrated into systems-of-systems which no person can understand fully, and even into systems-of-systems-of-systems (including the "Internet of Things", IoT, and autonomous vehicles): the only thing of which we can be certain is that EMI problems will occur more frequently and have larger impacts on cost and safety.

I hope these stories help identify possible EMI problems in advance, so that they are dealt with as part of the normal design/development procedure and don't create the embarrassment and costs of trying to correct poor EMC design after products have been shipped or systems installed.

If you have any suitable stories or know of any relevant research or reports, please tell me about them so they can be included (anonymously, if preferred) in this list.

Compiled by Keith Armstrong
keith.armstrong@cherryclough.com

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890 EMI Stories

1) 10MW power converters interfere with wired telephones over 12 miles away

To cope with increased North Sea oil production, two new pumping stations with 6 MW adjustable speed induction motor drives were built and installed in Scotland, one in Netherly and one in Balbeggie. Soon after commissioning the local power utility and the telephone company received a flood of complaints. Geographically the complaints came from concentrated pockets spread over an area up to 12.5 miles away from the 33 kV overhead supply lines feeding the drives. A payphone over 4 miles away from the power line was noisy enough to be almost unusable, whereas just across the street a householder's telephone was relatively unaffected. Other symptoms included loss of synchronisation on TV sets (rolling pictures) and ringing on the supply to fluorescent lighting circuits.

Although the drives had been designed to, and met the supply industry's G5/3 harmonic limits, the problems turned out to be with higher order harmonics than it covered, up to the 100th in fact (i.e. 5 kHz). The problem became a public relations nightmare for all involved, and culminated in questions being raised at Government level. Remedial EMC work was urgently required and was in fact accomplished, although under extreme difficulties because the cost of any downtime of the oil pumping stations was so high.

(Taken from: "Harmonic filtering of large induction motor variable frequency drives" by M J V Wimshurst of Hill Graham Controls, High Wycombe, U.K., and Allan Ludbrook of Ludbrook and Associates, Ontario, Canada. Presented at the 7th International Conference on Harmonics and Quality of Power (IEEE) at Las Vegas, October 16-18, 1996, pages 354-359 in the Proceedings. Also presented at the "Sixth International Conference on Power Electronics and Variable Speed Drives", Nottingham, UK, 23-25 September 1996, IEE Conference Publication No 429, pp 24-29, http://www.iee.org.uk/Library.*)*

2) PC proximity switches off bathroom shower

A (CE marked) portable PC carried up the stairs in a domestic household whilst operating, reliably caused the "power shower" in the bathroom to turn itself off if it was in use at the time.

(Personal communication with Editor in 1997)

3) RF interference in ambulance causes death

Medical technicians taking a heart-attack victim to the hospital in 1992 attached her to a monitor/defibrillator. Unfortunately, the heart machine shut down every time the technicians turned on their radio transmitter to ask for advice, and as a result the woman died. Analysis showed that the monitor unit had been exposed to exceptionally high fields because the ambulance roof had been changed from metal to fibreglass and fitted with a long-range radio antenna. The reduced shielding from the vehicle combined with the strong radiated signal proved to be too much for the equipment.

(An article in the Wall Street Journal reported in Compliance Engineering Magazine's European edition September/October 1994, www.ce-mag.com.)

4) Running Windows™ causes cat flaps to rattle

Computers used in a room close to a door fitted with a high-technology (magnetic) cat flap caused the latches on the cat flaps to rattle continuously whenever Windows™ was loaded or a Windows™ application run.

(From the New Scientist magazine, 7th May 1997, www.newscientist.com)

5) Poor power connections interfere with search and rescue satellite comms over large area

The Langley (USA) Air Force Base Rescue Co-ordination Centre reported that its search and rescue satellite was receiving interference on its 121.5 and 243 MHz distress frequencies. The area over which interference was a problem was around 8 square miles, which was significant because normal emergency transmitters on these frequencies can only be detected at ground level for about one mile. The problem was eventually traced to poor connections on an overhead power line.

(From an FCC Field Operations Bureau news release, 1994, also reported in Newswatch…EMC in Compliance Engineering European Edition January/February 1995, page 6.)

6) Desert Shield and Desert Storm suffered 'serious and significant' EMI problems

An advertisement for engineers for "The HERO Project" quoted Rear Admiral Roland T Guilbalt, Deputy Director, Electronic Warfare Division US Navy as saying that both Desert Shield and Desert Storm suffered from serious and significant EMI problems. We have no more information on this at present, but presume it was due to the very heavy use of high-tech civilian equipment used for the first time in a military situation.

(From EMC Technology magazine, 1993. HERO stands for Hazards of Electromagnetic Radiation to Ordnance.)

7) Mains harmonic currents increasing, causing overheating and other problems

Excessive mains harmonics in the London area, due mainly to the rapidly increasing use of personal computers, are causing overheating problem in AC power cables (including those that run under the Thames). In the offices where the computers are, it is increasingly common for the power-factor correction capacitors normally fitted to fluorescent lamps to blow (the electricians usually just remove the blown capacitors).

Damaged and overheated neutrals, and damaged electrical switchgear is increasingly seen as a result of harmonic mains pollution. In the US, fire insurance companies are being urged not to take on any new policies unless they have had the size of the neutral cables in the company concerned checked for their adequacy for the heating effects of harmonic currents.

(Personal communications with Editor, January 1998)

8) Hair dryer can be turned on spuriously by mains transients

Hartman Products of Los Angeles, California, has agreed to pay a civil penalty of $60,000 to settle allegations that it failed to file a report regarding a defect in the 1992 Hartman Pro1600 hair dryer. The CPSC (a US consumer safety agency) believes that these hair dryers can turn themselves on even when the on/off switch is in the "off" position. While the dryers' heaters start, their fans do not, potentially causing internal components to overheat and cause fires.

(Compliance Engineering May/June 97, www.ce-mag.com)

9) Radio-activated car keys unreliable due to EMI

The AA and RAC estimate that around 9000 breakdowns they attended in 1996 were the result of remote key fobs being blocked by RFI. An AA spokesman said: "The number of cars being produced with radio-activated keys is standard now. If we're getting 9000 now, what will the problem be like later on?". *(Electronics Times 13th Oct. 1997, www.eetuk.com.)*

10) Desk toy wipes floppy discs and distorts monitors

We recently bought what looked like a fine new idea for an executive toy. It consisted of a very strong magnetic base with lots of ball bearings attracted to it, which it was possible to form into beautiful sculptures. What we did not realise at the time is that magnets and office desks are not cheerful companions. But we soon found this out when the discs with our accounts on them were mysteriously wiped, and the monitor screen went all the colours of the rainbow. It is now only possible to use our office desk toy when not at our desks, and well away from the office.

(Letter from Michael Fell in 29 November 97 issue of New Scientist, www.newscientist.com.)

11) Electric wheelchairs erratic due to EMI

Wheelchairs have come in for special scrutiny by the FDA (the US Food and Drug Agency). A few months ago, the agency ordered makers of wheelchairs to shield them and to educate users about the potential hazards of interference. The FDA acted after receiving "many reports of erratic unintentional powered wheelchair movements." These included sudden starts that caused wheelchairs to drive off curbs and piers when nearby police, fire or CB transmitters were activated. Miraculously, no fatal injuries have been reported.

(But broken limbs have occurred as a result of such interference - editor.) (Compliance Engineering - European Edition September/October 1994, www.ce-mag.com.)

12) Railway signalling interferes with recording studio

Around 1990 Alan Little leased a derelict arch under the railway line in Camberwell from British Rail. He borrowed money to convert it into a two-level mix of recording and rehearsal studios. The total cost was pushing £50,000. Up until November 1991 it was popular with up-and-coming bands needing somewhere to rehearse and record. Then, one fateful Saturday morning, with three bands booked for the morning and three for the afternoon, disaster struck. All the studio equipment, and the bands' amplifiers, started warbling. The bands and studio crew thought at first that they had an equipment fault. Then other studios in other railway arches in the area began phoning each other. They all had the same problem. Alan Little phoned British Rail and on the Monday morning a BR engineer came round, listened and said the cause was a new signalling system installed by BR.

BR controls its track lights by feeding electric current through its rails. When a train runs over the rails it provides a short-circuit between them, triggering a red light behind the train. Recently BR has begun changing to the use of alternating current. The long rails act as a highly efficient aerial, radiating a powerful AC magnetic field *(this was actually around 1 Amp/metre over much of the studio - editor*). The AC is at audio frequency, using tones of between 1 kHz and 4 kHz. The tones are complex warbles, to safeguard the system from outside interference.

The effect was heard through the mixing desk, with pick-up from mains and connecting leads. It was even heard through unpowered loudspeakers (*even when they were disconnected from their cables and their terminals shorted - editor*). It was worst when an electric guitar is plugged into an amplifier. Guitar pick-ups are designed to convert their magnetic fields, modulated by the movement of the steel guitar strings, into sound. They cannot distinguish between magnetic fields from a BR signalling system and those from vibrating strings.

(*Extracted from an article by Barry Fox in Studio Sound Magazine, June 1992*)

13) Magnetic airline tray tables wipe hard drives

It was reported in the Sunday Times (15/2/98) and New Scientist (7/3/98) that Sabena Belgian World Airlines had installed magnetic tray tables in its new fleet of A340 Airbuses, to prevent the nuisance of rattling trays on their flights, but that these tray tables were apt to cause loss of data on PC hard disc drives.

New Scientist of 28 March reported that the story was untrue, but that tables of this sort had been discovered on a train from Frankfurt to Berlin. The conclusion seems to be that if you intend to use your PC in any kind of vehicle you should always carry a (steel!) paper clip and use it to check for magnetised tables.

14) Electromagnetic ‘bombs’

High intensity radiated fields (HIRF) guns and electromagnetic pulse transformer (EMPT) bombs are already easy to build from off-the-shelf components. The effects of even hand-built HIRF or EMPT weapons can damage microprocessors at ranges of hundreds of metres. Possibly, in a few years, a van equipped with suitable electronics could cruise down Wall Street (or through Canary Wharf - ed.) and disrupt the information processing capability of thousands of computers without being detected by the local police.

(Extracted from an article in the IEE's Control and Computing Journal, April 1998 (page 52), www.theiet.org.)

15) More on radio activated key lock-out problems (Banana Skin No. 9)

Most radio activated key-entry systems have a manual override. Unlocking the door can be as simple as inserting the mechanical key into the lock and trying the lock according to the instructions printed in the car manual.

(From an Electronic Times article on 29th September 1997, www.eetuk.com. The trouble with this advice is that the manual will usually be locked inside the car – or are we supposed to carry it around with us at all times?).

16) More medical incidents:

The magnetic field caused by ground currents in a water pipe system made it impossible to use sensitive electronic instruments in part of a hospital.

A patient-coupled infusion pump was damaged by an electrostatic discharge, but thankfully the alarm system was not affected and a nurse was alerted.

An operation using a plastic welding machine caused interference with a patient monitoring and control system, causing failure to detect that the circulation had stopped in a patient's arm, which later had to be amputated.

(*Taken from Compliance Engineering European Edition March/April 1998, ww.ce-mag.com*)

17) **Inadequate lightning protection led to serious explosion in oil refinery**

At 1:23 pm on Sunday, 24th July 1994 there was an explosion at the Texaco Refinery, Milford Haven. Its force was equivalent to 4 tonnes of high explosive and it started fires that took over two days to put out. Shops in Milford Haven 3km away had their windows blown in. 26 people sustained minor injuries, and the fact that it was Sunday lunchtime and the site was only partially occupied meant it could have been very much worse. Damage to the plant was substantial. Rebuilding costs were estimated at £48 million. There was also a severe loss of production from the plant – enough to significantly affect UK refining capacity. The incident was initiated by an electrical storm between 7:49 and 8:30 am on the Sunday morning that caused a variety of electrical and other disturbances across the whole site.

(Taken from IEE Computing and Control Engineering Journal, April 1998, pp 57 – 60, www.theiet.org. There is an HSE report on this incident: "The explosions and fires at Texaco Refinery, Milford Haven, 24th July 1994" HSE Books, May 1997.)

Comments by the Editor: I have not read the HSE report, but understand from private conversations with HSE experts that the large explosion was caused by the electrical storm giving rise to power surges which tripped out a number of pump motors whilst leaving others running. As there was a great deal of panic and confusion due to the information overload caused by the numerous small fires and equipment outages from the time of the storm, it was not noticed that flammable substances which should have been flared off were accumulating in pipework and vessels. After five hours something ignited the total accumulation, resulting in the large explosion.

The general incidence of surges in the UK's AC power distribution network is quite low, and this often leads people to believe that qualifying the power surge immunity of their products, systems, or installations is not important. This belief is often supported by the observation that neither of the generic immunity EMC standards included surge testing in their normative sections. But it only takes a single incident such as the above in the lifetime of even a very large plant to make an excellent economic case for a proper preventative strategy. Suitable basic test standards include IEC 61000-4-5 or IEC 61000-4-12 (ring wave), both of which are intended to simulate the indirect effects of electrical storms on power networks.

Engineers are always under pressure to save costs, and the costs of preventative measures are easy to quantify. However, many engineers are uncomfortable with estimating the risks of infrequent and unpredictable events such as thunderstorms so do not effectively communicate the actual risk/cost and safety implications to their managers.

As someone said recently: Doctors kill people in ones, but engineers do it in hundreds. Careers and personal liability are also at stake here too, so it is always best to make an informed cost/risk case and get a written decision from management. There is no shortage of advice and assistance on this sort of thing – sources include:

The Institute of Risk Management: phone 0171 709 9808, fax 0171 709 0716, or visit IRMG@aol.com

The Hazards Forum; phone 0171 665 2158, fax 0171 233 1806, Email: torey_d@ice.org.uk, or visit www.ice.org.uk

The Safety and Reliability Society: phone 0161 228 7824, fax 0161 236 6977, Email secretary@sars.u-net.com, or visit www.sars.u-net.com

The British Safety Council: phone 0181 741 1231, fax: 0181 741 0835, Email bsc1@mail.britishsafetycouncil.co.uk, or visit www.britishsafetycouncil.co.uk

Health and Safety Executive: Infoline: 0541 545 500, fax 0114 289 2333, or HSE Books: phone 01787 88 11 65, fax 01787 313 995, or visit www.open.gov.uk/hse/hsehome.htm

The IEE Library: phone 0171 344 5449, fax 0171 497 3557, Email libdesk@iee.org.uk, or visit www.iee.org.uk/Library/libgen.htm

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The Engineering Council: phone 0171 240 7891, fax: 0171 240 7517, Email: info@engc.org.uk, or visit www.engc.org.uk

18) **CE marked 8kA DC motor drive causes severe interference with monitors**

A very powerful (±8,000 Amps) DC drive was recently purchased and installed in an industrial plant. It was contractually agreed that it would meet and be declared compliant to the EMC Directive. A control room was also required (like most modern control rooms it was full of PCs and CRT-based VDUs) and the drive manufacturer said that it could be installed near their drive cabinets. When the drive was operated the images on the VDUs were squashed into 50% or less of the screen width. It was possible to tell the direction and loading of the drive directly from the movement of the VDU images, which of course were completely unreadable. The magnetic fields caused by the drive were of the order of 235μT, and most CRT-based VDUs show image movement at greater than 1μT (1μT is approximately equal to 0.8Amp/metre and to 10 milligauss).

The drive manufacturer claimed that his drive did meet the EMC Directive despite the fact that it caused interference with the control room VDUs. What they in fact meant was that it met the industrial generic standards, which do not include any limits for low frequency magnetic field emissions. They forgot that their EMC Declaration of Conformity binds them to not causing interference of *any* kind, and that compliance with a harmonised standard only gives a presumption of conformity.

The situation has been remedied by the use of LCD screens, which have only recently been available with a specification suitable for the SCADA system that was used. "Dog kennel" magnetic shields and active field cancellation devices were also investigated. The delay in the use of the control room was several months, and this had an impact on productivity far beyond the cost of the remedial measures.

(Submitted by an EMC Consultant who wishes to remain anonymous, May 1998.)

19) Bathroom fan triggers security lights, which then cause radio to switch on

We've learned to live with the condition that if we get up in the middle of the night to use the bathroom, when we turn the light on the fan timer starts. The fan will keep running for twenty minutes, and when it turns off it causes interference that turns on the outside security light (infra-red triggered 500W halogen) which then runs for its time period (15 minutes) whilst shining through the bedroom window.

Now you'll have difficulty believing this bit... Monty Python eat your heart out... before the 500W halogen lamp we had a high pressure sodium lamp with an inductive ballast. When this switched off it would cause interference which would sometimes start the bedside radio. So the scenario was this...

Get up at 2:00 am, go to bathroom, turn on light, turn off light, go back to bed, and after twenty minutes a bright light would shine through the window and wake you up. If you slept through that (or went back to sleep), fifteen minutes later when the light switched off the radio would start, and then you would wake again.

The moral of this story? If you have bad EMC immunity make sure you use the bathroom before you go to sleep.

(From Chris Dupres via emc-pstc@ieee.org, 8th July 1998)

20) Licensed TV transmissions interfere with intensive care, kills babies

While taking classes in the early 80's, my professor got involved with a terrible incident down in New Jersey. Seems a hospital had a high incidence of infant deaths in the intensive care section of the maternity ward. Late at night, the alarms on the babies' monitors would go off for no apparent reason. Annoyed, the nurses would turn them off and do the rounds on foot.

After some preliminary investigations, my Prof found out that a nearby TV transmitter was allowed by their FCC license to increase their output wattage by some enormous amount after say midnight but had to reduce it prior to 6am, or some such arrangement. The cable interconnecting the nurses station to the various baby monitors sang like a lark with these frequencies and set off alarms with the induced voltages.

Not sure now of all the specifics except what I have related above nor the name of the hospital, but they lost something like 6 kids before fixing it.

(From Doug Mckean, via emc-pstc@ieee.org, 29th July 1998)

21) 'Impossible' 50% brown-out occurs for 8 hours in the UK

Undervoltage AC supplies (brown-outs) are common in underdeveloped countries, or where the AC supply network is incorrectly configured. Parts of Spain are known to experience around 150Vac for lengthy periods during the day, apparently due to network loading, despite an officially-specified mains supply of 230Vac ±6%. I had never experienced a brown-out in the UK, except maybe for a second or so prior to a complete supply failure during a thunderstorm, and I used to think that it must not be possible because of the way the supply network is operated here.

On Sunday 26/7/98 around 5pm in Denshaw village, Lancashire, U.K., the supply dropped to around 140Vac RMS (40% below nominal), and stayed at that level for about three hours before shutting down completely as the engineers arrived to fix the problem. We switched off our fridge and other motor-driven appliances, mainly because they were making very strange noises. Our computers kept running, but the CRT screens blanked, making us concerned about what was happening to our data, so we switched them all off as well.

I am aware of electronic control equipment that can misoperate when operated considerably outside its specified AC supply range, and also understand that undervoltages can damage coils and motors. Apparently the motors can stall due to the low voltage, so they don't generate back-emf, so they draw excessive currents and overheat, damaging their insulation and suffering premature failure (if not electric shocks and fires).

Manufacturers of products for the developed world, and their safety test laboratories, usually do not test at supply voltages outside ±10% (sometimes ±15%). Until Sunday 26th July I had not thought this important. So far we have not discovered any damage to appliances or to data.

(Submitted by Keith Armstrong, Cherry Clough Consultants, www.cherryclough.com.)

22) Ball lightning during in-flight refuelling

There was film footage on TV some years ago of a British in-flight re-fuelling exercise where the tanker aircraft was hit by lightning, but there was no on-going discharge downwards, the implication being that the plane was left charged to 100kV - 1MV or whatever.

A few seconds later great balls of glowing gas came off the back of the fuselage and wing tips (where the fuel hose was) into the slip stream, presumably taking away a whole load of surplus electrons, or holes - whatever it was - as "ball lightning".

(From Chris Dupres via emc-pstc) (The Editor comments: New Scientist magazine recently reported that a theoretical basis for ball lightning may have been found, www.newscientist.com.)

23) Electrostatic charging of helicopters

Helicopter blades and bodies tribocharge as they swish through the air, and they don't have a convenient green/yellow wire handy. There are reports of an oil rig computer system crashing whenever a helicopter landed, due to its sudden electrical discharge into the metal decking, and there is a film which shows a crew-member getting an awful shock when he reached up to touch the skids of a hovering helicopter.

A US Coastguard Chief related to me that he had seen "arcs as bright as a welding stick" when an emergency pump was delivered to the deck of a freighter one night. He also told me that the Coast Guards' standards practice calls for NEVER lowering a flotation ring or sling to a person in the water; the person will automatically reach for the line! Instead, they dip the line into the water and drag it to the person.

(The above are from Chris Dupres, via emc-pstc@ieee.org.)

24) Interference with a travelling crane

A new CNC machine being installed in a factory had a spindle controller which was a small inverter drive in a plastic case. When the spindle was first operated emissions from the inverter caused a overhead travelling crane to start up and drag its chains down the length of the factory. Luckily, the 18 ton casting the chains had been attached to had just that minute been released.

(Submitted by Phil Hampton.)

25) Two more examples of interference with cranes

There was the famous case reported by the DTI in the early days of their EMC Awareness Campaign of the guy who was standing under his crane's load using his radio-control pendant when interference caused it to release its load, crushing him to death. Many recent crane incidents are due to the use of radio control, especially where crane radio-control systems share the same frequency bands as amateur radio and/or car radio-keyfobs. The soon-to-be-introduced TETRA system also shares some of these bands, and use 25W transmitters – so expect more wild cranes.

Just to prove that modern technology can't teach old technology any interference lessons, I once worked for a company that I was told had made the controls and drives for the first large-scale hovercraft testing tank in the late 1960's. It was in effect a sophisticated travelling overhead crane, which ran a gantry along overhead rails and towed a hovercraft shape along a large pool of water in an even larger building. In those days they used resistor-transistor logic which ran on a 40V rail to provide noise immunity. During commissioning the machine suddenly started up by itself and proceeded towards the far end of the pool – it had been set off by "some sort of mains transient". All the personnel on the site were standing by the access ladder to its gantry, but the only emergency stop button was on the gantry – but it and its ladder were moving just faster than running speed and they couldn't get to it. Since it was not operating according to its (hard-wired) programming, the crane ignored its limit switches and crashed clear through the end wall of the building. Luckily nobody was hurt. The next version had E-stops all around the building.

(Submitted by Keith Armstrong, Cherry Clough Consultants, www.cherryclough.com.)

26) Foetal heart monitor picks up cell phone conversations

A foetal heart monitor in a clinic in the UK in June 1998 picked up a cellphone conversation from elsewhere on the premises quite clearly. The visual output of the monitor was unaffected, but the staff tend to use the audio output, and the cellphone conversation was so loud that it swamped the heart signal they were listening for.

It must have been an analogue cellphone, and it must have been getting in via the audio stages, or else the visual output would have been distorted. Even slow opamps will demodulate 900MHz signals (as hearing aid wearers are only too aware!). In common with many healthcare promises, the use of cellphones on the premises was banned, but you can't rely on people to read or follow signs.

(Submitted by Ian Ball)

27) RF welder fields set fire to bed 60 yards away

A 40kW RF welder (a dielectric welder for plastic materials) in use in a factory caused a mattress in a bed manufacturer's factory 60 yards away to catch alight. The bed springs must have just been the right length to make an efficient antenna at the frequency the welder was using.

(Anonymous submission, date of event not specified.)

28) Digital TV can suffer more from EMI than analogue

Digital TV is more likely not to deliver a programme to the viewer than the analogue TV services it replaces. It appears that this newer technology is less robust, and that its users will on average suffer a higher loss of service than they may have become used to.

Broadcast digital TV, which can be picked up with existing TV antennae, has a sharper cut-off in performance as signal strength declines. R.S.Sandell, a Fellow of the IEE writing in IEE Review November 98, is concerned that: “Whereas analogue viewers can live reluctantly with a picture that has to be viewed through varying angles of ‘venetian blind’ and alternating densities of ‘boiling porridge’, they can still follow the programme plot for most of the time. This dubious advantage may not be available for some members of the digital generation, who will be confronted by a blank screen. In particularly unfortunate reception location this condition may come and go with time as field strengths vacillate”. Viewers using indoor aerials (the TV with the rabbit ear antenna in the kid’s bedroom?) may find they need to invest in new external aerials or aerial amplifiers and splitters.

Satellite-delivered digital TV is very susceptible to lightning storms, both at the uplink and downlink ends. This leads to the odd situation, when watching digital satellite TV in South Africa during very fine clear weather that thunderstorms near the uplink in Europe can cause all 100 channels (or however many there are) to disappear all together for periods of several minutes. This phenomenon was well understood by the satellite broadcasters, who broadcast a little presentation on this topic every now and again.

(From Keith Armstrong of Cherry Clough Consultants, www.cherryclough.com.)

29) Jam GPS over 200km range with 4W pocket-sized Russian unit

GPS is another example of an advanced technology that everyone wants to use, but which has important susceptibility problems. The signals from the GPS satellites are very weak, so the receivers have to be correspondingly sensitive, which means they are readily swamped by interference from industrial sites. Even though they are at microwave frequencies, interference with satellite communications caused by such commonplace things as poor quality power line connections has been observed several times. Added to this, the need to “see” several satellites at once means that GPS is unreliable in the urban canyons of cities.

I was intrigued to see two items on GPS in the New Scientist magazine dated 10th January 1998. The first was an article about the concern of the US military about a Russian GPS jammer. With only 4W of power (about the same as a hand-held CB or security guard walkie-talkie) this device is claimed to prevent GPS systems from working over a 200km radius (yes, 200 kilometres!). Apparently any competent electronic engineer could build such devices from readily available components. The second item in the same issue was an advertisement from BT for their MoBIC mobility system for blind people. This uses a computerised map, speech simulator, and GPS to guide blind people to their destination. Quote: "Getting around the shops is much easier since I started using the US Military's Satellite Guidance System."

Designers building GPS into their products, especially where these are used for critical purposes, might like to consider the lack of robustness and ease of jamming of this system. I have visions of hordes of planes, cars, and pedestrians all milling around a factory until a certain machine is switched off, because their satellite navigation systems are blocked by its microwave noise.

(From Keith Armstrong of Cherry Clough Consultants, www.cherryclough.com.)

30) Rodent repeller interferes with Amateur Radio

Interference in the Amateur Radio 144MHz band traced to an ultrasonic rodent repeller.

(Brad Thomson, Editor of Test and Measurement World, Feb 95, www.tmworld.com.)

31) Domestic appliance interferes with surround-sound processor

The operation of a domestic appliance used to reset a surround-sound processor, causing a ½ second gap in the audio

(From Neil Gardner, Plantronics, August 98)

32) Taxicab radios interfere with control of Hi-Fi system

An advanced hi-fi system would change input selection due to taxicab radio transmitters when they called at a public house 100yards away.

(From a Technical Director of Lumonics, 1996).

33) Cell phone interferes with digital watch

A Tissot Two-Timer digital/analogue wrist-watch went into time-travel mode (about x 60) whenever a particular Motorola Micro-Tac portable phone nearby had someone actually speaking into the mouthpiece.

(Chris Duprés, 7th July 1998. It was his watch!)

34) Several examples of interference

With over 18 years in EMC I could go on listing interference incidents for a long time. Some examples this year already: My computer (FCC Class B) interferes with my cordless phones, to some degree on all 10 channels. My fax machine (FCC Class B) interferes with my TV and some channels of my cordless phones. My garbage disposal unit interfered with everything! My small personal fan destroys my monitor picture.

(From Derek at LF Research, 6th July 98, www.lfresearch.com.)

35) Microwave cookers interfere with car security

Domestic microwave ovens can activate the microwave security sensors fitted to some vehicles.

(From Terry Beadman, Motor Industry Research Organisation (MIRA), 6th November 1998, www.mira.co.uk.)

36) EMI implicated in two capsizes

The Canadian Centre for Marine Communications claim there is evidence that EMI may have contributed to two boat capsizes, via autopilot malfunctions. One was the 16metre fishing vessel the "Dalewood Provider" on August 17 1989, the other was the 64 tons "Martin N" on April 25th 1987. In the latter case three lives were lost. In both cases the concern is that the on-board VHF radiotelephone system interfered with the autopilot sufficiently to turn the rudder hard over. Staff at the Centre report that erratic alterations in a boat's course when autopilot is engaged and VHF radio used is commonplace, generally due to insufficient EMI suppression at the autopilot's interface and control cables.

*(Extracted from: "*Need for EMI/EMC Standards and Regulations on Small Boats: a Canadian Perspective*" by Byron R Dawe and Albert Senior of the Canadian Centre for Marine Communications, and Peter Ryan of Fisheries and Oceans Canada, EMC Technology magazine, Nov/Dec 1998, pages 17-19.)*

37) Chlorine gas release caused by mains transients – prosecution

The HSE recently prosecuted the supplier of an item of equipment which led to a release of chlorine in a semiconductor plant. The equipment was not sufficiently immune to mains transients (and proven to be so by the HSE's own labs). They were prosecuted under section 6 of the Health and Safety at Work

Act because the supplier, though aware of the problem, did not inform the users of the equipment. The company pleaded guilty.

(From Simon Brown of the UK's Health & Safety Executive (HSE), 13th January 1999)

38) Cell phones can interfere with pacemakers

The Therapeutic Goods Administration of Australia (TGA) continues to review findings of clinical and laboratory research indicating a potential for temporary interaction or interference between mobile phones and the operation of pacemakers and implantable defibrillators. The findings have indicated that interference may be caused by holding the phone within about 150mm of the implanted device, or in direct contact between the phone antenna and the user's skin. Interference can occur with the phone in standby mode, as well as in use. Some phones incorporate magnets, at least in their loudspeakers, and while held close to the implanted device these can cause them to go into their "magnet" mode, which for a pacemaker is a fixed pace.

Based on the most recent testing, simply moving the phone away from the implanted devices will return it to its correct state of operation. Recommendations for users of implanted pacemakers or defibrillators include: not keeping the phone in a pocket over the site of an implant; using the ear that is furthest away from the site of the implant when using the phone; and not allowing the phone antenna to touch any part of the body.

(From Compliance Engineering's European edition Jan/Feb 1998, www.ce-mag.com)

39) Pinball machines interfere with emergency services' radio comms

There is a story of how something was causing havoc with the emergency services' two-way radio communications in Nevada, i.e. police, fire, and ambulances. An exhaustive investigation led to one or more really noisy pinball machines at a roadside pub (editors note: I thought they had bars in Nevada instead of pubs). The owner was ordered to get rid of them. He got rid of them and the problem went away. However, it soon reappeared, as another pub owner wound up with the same machines.

(From George Alspaugh of Lexmark International, 7th July 1998.)

40) Kitchen fan triggers security lamps

I have a security floodlamp system for my backyard, equipped with a thermal motion sensor. I have found that I have a reliable, though unintentional, remote control capability simply by flicking the kitchen range fan on and off a couple of times. I told my wife that it's a special purpose, hard-wired, digital controller.

(From Ed Price of Cubic Defense Systems, San Diego, 8th July 1998, www.cubic.com.)

41) Eurostar north of London delayed by concerns over interference

Eurostar and Railtrack officials admitted this week the threat of EMI causing signal failures is delaying the introduction of European rail services north of London. EMI generated by overhead power lines can affect the trackside signals such that red lights are forced to green. A Eurostar spokesperson said: "In electrical terms, we have found with new trains, such as Eurostar, there tends to be a degree of stray electrical current. This can cause an interference with signalling and affect the integrity cause a signal to go from red to green." Railtrack, responsible for the track and signalling systems, is refusing to allow the trains to run commercially until Eurostar can demonstrate their safety.

"We are working hand-in-hand with to solve this problem as quickly as possible," Railtrack said. Eurostar engineers have designed an interference current monitoring unit. When it senses EMI, the motor is stopped and the train coasts to a stop. However, for the highest safety the unit must be set to maximum sensitivity. This could cause the train to stop every few miles.

(*From Electronics Weekly October 23rd 1996*) *(Editors note: has anybody seen a Eurostar north of Watford Junction yet? How much has this cost our national economy, especially northern companies? I understand that all Eurostar trains have had TCFs done for them under the EMC Directive and that traditionally both British Rail and Railtrack always imposed stringent EMC immunity standards on their signalling equipment, using the RIA series of standards.)*

Also see the Lords Hansard text for 14th July 1998 (180714-02) in which Baroness Hayman, Parliamentary Under-Secretary of State, Department of the Environment, Transport and the Regions stated:

"My Lords, the technical issues which prevent the operation of regional Eurostar rolling stock on parts of the existing network relate to electrical interference associated with track circuits. These matters have prevented the issue of safety clearances which are required before passenger services can be

operated."
(http://www.parliament.the-stationery-office.co.uk/pa/ld199798/ldhansrd/vo980714/text/80714-02.htm)

In October 2003 the interference problems still did not seem to have been solved. The editor has since been informed that plans to run Eurostar trains north of London have now been shelved.

42) Railway trains banned over interference

There are a number of railway trains that have been unable to be taken into service because they interfere with signalling.

(From Ray Garner of Datel Defence Ltd, November 98, quoting an earlier article in a national newspaper.)

43) Induction furnace interferes with high street store's computers

A 1.5 MW induction furnace controlled in on/off time-proportioning mode (using large contactors to switch the current) interfered with the computers in a Marks and Spencer's store ½ mile away.

(From Laidler Associates Consulting Services, June 1998, www.laidler.co.uk.)

44) Turbogenerator support distorted by heating from incorrect cable installation

A new large turbogenerator in a UK power station was designed to have its 20kA three-phase output busbars split either side of one of its support pillars, because of a lack of space. The support pillars were steel, part of a steel framework, and created a single-shorted turn around one of the busbars. In operation, the pillar (made of 2 inch thick steel members) got hot enough to blister its paint, and increased in height by 5mm, putting a bearing out of alignment and causing a terrific noise which caused the station workers to run for their lives. *(Editor's note: a large turbogenerator up to speed and adrift from its bearings is a fearsome object!)* The cure was another shorted turn, this time around the pillar and made of ½ thick aluminium.

(Conversation at Mersey and District Club Européen, 28th January 1999.)

45) Further information on Banana Skin No. 37: Chlorine release

The case referred to was heard at Swindon Magistrates Court on November 25th 1998. The defendant entered a plea of guilty to a charge brought under S6 (1) (d) of the Health & Safety at work etc. Act, 1974. The magistrates imposed a fine of £5,000 and made an order for the defendants to contribute £7,000 towards HSE's costs of £9,482. The case concerned a microprocessor based valve control panel used to control the flows of chlorine and nitrogen in a semiconductor plant. There had been a release of chlorine resulting from all of the valves in the control cabinet being set to an open position.

Investigation by the HSE found that the unit was susceptible to conducted transients on the mains supply. There were no precautions against electrical interference in the power supply and the microprocessor watchdog was not effective in ensuring a safe state following detection of a fault. The HSE inspector who dealt with this case was Eifion Davies in our Cardiff office.

(From Simon Brown of the HSE, 3rd March 1999)

46) Monitor image wobble caused by magnetic fields

Scenario: Large open-plan office in a publishing company. Lots of eager beavers with 21 inch displays on their MACs, doing all sorts of clever graphics things for page make-up and other arcane processes.

Problem: The displays on only some of the monitors oscillate sideways about 0.5 mm at most, at about 1 Hz.

Diagnosis (partial): The combined magnetic fields of mains cables under the floor and a power transformer on the floor below are sufficient to cause this very small effect. Unfortunately, once you notice it, it keeps catching your eye and it eventually drives you mad! The 1 Hz is due to a beat between the third harmonic of 50 Hz and the second harmonic of the 75 Hz frame rate of the displays.

Solution: Move the transformer. Replace the large feeder cable to it by individual lower-current feeds to the loads served from it, spread out across the void below the office floor.

Continuing problem: Now that the sideways movement has been eliminated, an even more subtle "vertical" movement of the displays is discovered. Again, it's difficult to see, but once you see it, you can't ignore it. This effect is not continuous: it occurs for a few minutes and then disappears for about ten minutes or more.

Diagnosis: An air-conditioning unit is found to have an intermittent fault to earth, resulting in some 3 A flowing in the armour of the cable feeding it. This current is not balanced by currents flowing in the conductors of the cable, and creates a 50 Hz magnetic field with a horizontal component sufficient to cause the effect.

Solution: By turning a monitor through a right-angle, so that the strong horizontal component of the field is parallel to the electron gun axis, the movement disappears. However, it is obviously necessary to correct the potentially hazardous fault in the air-conditioner.

The main point here is that the tolerable amount of display movement is "very small indeed" when people are working on complex artworks on large-screen displays.

(From John Woodgate, 8th March 1999)

47) Mains spikes blow fuses in poorly-designed control panel

The relaxed attitudes of those times did not always pay off, however. Slightly later in my career, I moved to a company where engineering standards were, lets put it politely, a little lacking. For example, interlocking between contactors in reversing pairs was considered an unnecessary expense, and no one would ever consider such niceties as interrupting capacity when selecting a fuse. If the current rating was right, the fuse was good enough for the job.

The error of these ways wasn't long in revealing itself, however. In one mechanical handling job, we had around a dozen reversing starters, all protected with totally inadequate fuses. Even worse, the contactors were controlled by some very dodgy solid-state switches which had been "designed" in-house. Now, in those days, EMC hadn't even been invented. The result was that even the slightest spike on the supply made these solid-state switches turn on – just for an instant – but long enough for all of the contactors to jitter. Frequently, both contactors in a reversing pair would close for an instant, placing a short-circuit across the supply. This meant a mighty bang as the inadequate fuses shattered and spilled their silica contents all over the floor of the enclosure.

After a lot of time on site, during which much wiring was re-arranged and many capacitors were added to the system, we managed to get the equipment working after a fashion but, ever since, I've been suspicious of control panels with a layer of silica sand in the bottom!

(Taken from "When I was a lad…" *reminiscences by Keith Wilson, Panel Building Magazine, February 1999, page 17)*

48) Screened leads that weren't

I was testing an item of IT based instrumentation the other day that failed conducted emissions. We replaced its 3 metre long screened 25-way D-type lead, which had been purchased as a "fully screened cable" from a well-known distributor, with my own home-made 15 metre long 25-way D-type lead, which simply used a single braid cable and metallised plastic backshells. The conducted emissions problem (on the mains lead) went away. My customer is now trying to source cables which <u>really are</u> screened. So *caveat emptor*, even when buying from large distributors.

(From Ian Ball of A. D. Compliance Services Ltd, which used to be Dedicated Micros EMC Test Centre.)

Items 49-52 below are four real-life case-histories of industrial projects that failed in a big way, due a failure to correctly appreciate EMC. The names and details that might allow identification of the companies concerned have been suppressed for confidentiality

*These examples have been extracted from the paper "*The Real Engineering Need for EMC*" by John Whaley, General Manager of SGS International Electrical Approvals (UK), presented at the IEE event "*Electromagnetic Compatibility in Heavy Power Installations*", Teesside, UK, 23rd February 1999, www.theiet.org.*

The other papers from this event will also be of value to anyone involved with industrial products and installations (not just heavy power applications). Contact IEE Sales and ask them to send you digest reference 99/066. These cost £20 each for delivery in the UK, and they normally require a cheque for the full amount before posting. An extra postage charge may be made for overseas customers. Phone +44 1438 313 311, fax +44 1438 313 465, or e-mail: sales@iee.org.uk.

49) Failure to correctly specify EMC performance

A large manufacturer of industrial fasteners, negotiating with a major customer, agreed to install a packaging cell containing an automatic weighing machine that filled plastic packets with fasteners and an RF welding machine to seal the packets. For cost reasons the two machines were purchased separately. No assessment of the electromagnetic environment took place, and the machine contract specifications included no EMC requirements other than "shall meet all legal requirements".

Both machines were supplied, installed, and tested successfully. Unfortunately when both were operated together the weighing machine suffered >25 % errors due to interference from the RF used by the welder (not an uncommon problem). In an 8 hour shift the cell should have packaged £20,000 of fasteners, but could have given away up to £4,000 of product in incorrect weights.

There was no comeback on the machine suppliers, whose products met specification. Both suppliers appeared willing to help, but when pressed blamed each other. Expert technical assistance was brought in and solved the problem. The fastening manufacturer lost 6 weeks production, suffered additional costs, and lost credibility with their major customer.

50) Over-specification of EMC

A machinery manufacturer needed a special inverter drive for a new range of machines, and out them out to tender. A manufacturer of AC inverters won the contract for this large project against stiff competition, but didn't notice that the specification required meeting military EMC standards. Their normal inverter designs failed the EMC tests, and their customer refused to accept them. Not having experience in military EMC, time and effort was wasted only to find that the redesigned inverters would not meet functional specifications.

As a direct result, the inverter manufacturer went out of business. Their customer's machine introduction was consequently delayed, leading to loss of revenue and loss of market credibility. The machinery manufacturer should have correctly assessed the electromagnetic environment of his product, and realised that military EMC standards far exceeded what he really needed.

51) A cost reduction exercise that didn't

A manufacturer produced high-quality industrial equipment sold throughout the world. New management thought that poor financial performance was because their products cost too much to make, so began a cost reduction exercise that included employing a production engineer to make design changes.

The designers had been using historically-generated design rules to give their products their famous reliability. These included EMC protection developed over many years of reacting to interference problems in the field. The design departments had no real understanding of EMC, did not realise what protection was lost by the changes, and were unable to suggest cost-effective alternatives.

A number of machines were built to the new design, and with a new price structure sold well in the UK and particularly well in the USA. Unfortunately the product was unreliable due to poor immunity to real-life electromagnetic environments. The consequences included one customer rejecting a product, and the basing of a commissioning engineer in the USA for over one year, as well as loss of product reputation.

Reducing company profitability by employing cost-reduction techniques is not uncommon. *Cost-effectiveness* techniques should be used instead, taking account of all the consequences of change. In this case the history of the product should have made it clear that EMC expertise was required.

52) Mistakes with a cabling installation

A major manufacturer of automotive parts commissioned a series of robot controlled paint booths with a total project cost of over £2 million, and correctly specified their EMC performance. The successful supplier agreed to meet these EMC requirements, and accepted financial penalties in case of non-delivery. To save costs, it was agreed that the supplier would install his paint booths but the user would arrange for their cabling to be installed by local contractors.

When installed, the paint booths suffered apparently unconnected (and sometimes dangerous) faults and the user would not accept them. Investigations by both the user's and supplier's staff could not identify the problems. The user had problems meeting his production deadlines and had to employ extra painters, while the supplier started to incur financial penalties for late delivery. An independent consultancy quickly identified that the screens of all the interconnecting cables had been terminated in a daisy chain to a local earth (which was not the equipment earth), allowing interference with the control electronics.

The supplier normally used its own trained installation staff to install its products, and had no written instructions on the correct termination of the screened cables. Unfortunately there was no easy answer and 80% of the cables had to be replaced (using the correct screen terminations). The supplier picked up the bill.

Costs to the Customer	Costs to the Manufacturer
Loss of production	Financial penalties under the contract
Extra painting staff costs	Additional costs of investigation (staff)
Additional costs of investigation (own staff plus independent)	Additional re-wiring Costs.
	Loss of customer's confidence

The legal arguments about who was at fault continued for some time, but the lack of cable installation instructions from the paint booth supplier was the determining factor. Arguments that his staff normally installed his equipment were discounted, as he had agreed this would not happen on this contract.

53) Power dip problems solved using superconducting energy storage

The paper mill at Stanger (South Africa) has a modern electronic variable speed drive system rated at 1MVA. A thyristor-controlled rectifier controls the common DC bus voltage of the individual drives. The motors are independently driven, speed-synchronised units transporting the continuous paper web at high speed. Voltage dips of more than 20%, lasting in the order of 40 ms, are enough to upset the sensitive controls and shut down the drives. This tears the paper web and results in several hours of downtime for cleaning and re-threading.

The paper mill used to experience at least one or two such voltage dips a week in its power supply, but since the installation of a superconducting magnetic energy storage system in April 1997, configured as a voltage dip protector, not one shutdown has been caused by voltage dips on the supply from the feeding grid.

(Adapted from an article by R Schöttler and R G Coney in the IEE Power Engineering Journal June 1999 special feature on electrical energy storage, www.theiet.org.)

54) TETRA radio system interferes with car keyfobs

Ken Yard of the Radiocommunication Agency described the problems it had recently faced with the introduction of the TETRA services to the UK. Interference to car alarms and immobilisers had caused over 12,000 call-outs on roadside recovery services in the last year alone. He said that the problem was partly caused by TETRA base stations but the main cause was poor quality receivers (in the car system) with insufficient rejection of out-of-band transmitters. He hoped that this situation could be avoided with the new 868MHz band for car keyfobs.

(From the article "Compromise on 868 MHz"*, page 14 of Low Power Radio Association News May 1999, describing a meeting on March 23rd 1999,* www.lpra.org/news/index.php. *If your present car keyfob uses 418MHz, you could easily suffer from TETRA during the coming months and afterwards. If it uses 433MHz you may escape - if your receiver is of good quality.)*

55) New kidney dialysis machines very susceptible to power quality issues

Power quality is especially critical in hospitals, where life-sustaining processes demand clean reliable electrical supplies. This was recently highlighted at Glan Clwyd Hospital in North Wales where a problem became apparent on the renal dialysis unit during the testing of emergency generators. The switch from mains power to generator power was causing the newer, computer-controlled dialysis machines to close down and generate an alarm. This caused distress to patients and problems for staff who needed to reset several machines quickly before their blood began to coagulate.

Resets were generally successful, though occasionally a unit would not respond so a patient would need to be moved onto a spare machine. The problem was solved with uninterruptible power supplies to provide continuity of operation at the hospital during generator testing. Ten 2.5kVA UPSs are now used in the dialysis unit and one on a treadmill in the cardiovascular unit to safeguard patients from injury should power failure cause the treadmill to stop suddenly.

(Extracted from page 121 of IEE Review, May 1999, www.theiet.org. Take care: not all UPSs appear to be as reliable as we might wish!)

56) **Aircraft carrier interferes with garage doors in Hobart, Tasmania**

Hobart in Tasmania suffered an unusual blight earlier this month. Residents all over town found themselves trapped in their garages when the remote controls that operate the garage doors suddenly failed to function. Roll-a-door companies were flooded with calls from angry garage owners and were at first completely nonplussed by the problem.

Then the explanation emerged: the aircraft carrier USS Carl Vinson had just cruised majestically into the town's docks, equipped with navigational radar employing the same frequency as the remote controls for the town's garage doors. According to the local newspaper *The Advocate*, an apologetic Lieutenant Dave Waterman, the ship's public affairs officer, said that the problem would only occur when the ship was arriving and leaving.

(New Scientist, 24th April 1999, page 100, www.newscientist.com.)

57) **Screening cable helps engine run smoothly**

A control cable to the engine management system of a motor car was damaged, and repaired with a terminal block. But the engine ran rough. Wrapping the repair all over with EMC copper tape (conductive adhesive) made the engine run smooth again.

(Arthur Harrup, Chief Engineer, William Tatham Ltd, Rochdale, 16th Feb 1999)

58) **Three examples of interference from UK Trading Standards**

Some robotic toys interfere with TVs. Some touch-controlled lamps interfere with long-wave radio, even when their light is turned off. An illuminated (battery powered) yo-yo interfered with a Porsche.

(Jim Rackham, Principal Trading Standards Officer, 23rd February 1999)

59) **Chart recorder runs at double speed on Saturdays**

During the 1980s we used a French make of chart recorder, which often ran at double speed on Saturdays. This turned out to be due to the increased numbers of TVs and radios in use on a Saturday, whose power supplies injected second harmonic currents into the mains supply. The synchronous motors in the chart recorders were able to latch up to the resulting 100Hz voltage distortion, and consequently ran twice as fast.

(Stan Lomax of RTM Group Ltd, Altincham, March 99)

60) **Cable TV interferes with aircraft navigation and radio comms**

The German economics ministry is considering restricting cable TV networks because of mounting concerns about their possible impact on air traffic safety. Frank Krueger, an economics ministry spokesman, says that the possibility that interference from household cabling will interfere with aircraft navigation and ground communication systems has prompted the government to propose regulations. "It is possible that, in individual cases, certain stations will have to be closed down after a review of the dangers posed by their frequencies." said Krueger. According to the European Cable Communications Association, the discussion about cable broadcasting and air traffic safety is not confined to Germany.

Similar safety issues are currently being discussed by the Benelux states and the Nordic countries. The UK Radiocommunications Agency says that, as far as it is concerned, the only debate surrounding clashing transmissions relates to avoiding potential interference with other European broadcasters. *(From the lead article on page 1 of Electronics Times, April 1999, www.eetuk.com.)*

EMC consultant Diethard Hansen has written: "In spite of using coaxial cables in the TV distribution systems there is a lot of shield leakage, based on technical imperfections and ageing. Catastrophic emissions in the aeronautical security bands are jamming Germany."

*(From: "*Megabits per second on 50Hz power lines*", Diethard Hansen, IEEE EMC Society Newsletter, January 2001, http://www.ewh.ieee.org/soc/emcs.)*

61) **Millennium Wheel installation delayed by interference from microwave comms**

The Millennium Wheel on the Embankment in London was supposed to be lifted on September 12th 1999. One of the delays was caused by an EMC problem. *The Daily Telegraph,* Saturday September 11th 1999 (page 6) said: "The operation had fallen victim of the publicity that it had generated because the satellite dishes on the fleet of television vans covering the event interfered with the laser signals monitoring the cables pulling the wheel upright."

The Guardian, September 11th 1999 said: "Work was initially delayed when satellite dishes on media vehicles interfered with electronic equipment used to monitor the lift, and further hampered when a stabilising cable had to be re-routed."

The Engineer, 17th September 1999 (page 2) chose to ignore the EMC issues altogether and focussed instead on the problems with the stabilising cable and its wheels, brackets, and lateral pins.

62) Copying machine interferes with CAD system

An engineering company invested heavily in a networked computer-aided design (CAD) system. However, the system's many advantages were overshadowed by the all too regular problems it suffered. The system would crash unexpectedly, sometimes hours of work were lost or corrupted and circuit failures seemed to be almost a monthly event.

At first these were assumed to be just "teething troubles" but as time went on, and design work slipped further and further behind schedule, relations with the system's supplier became increasingly difficult. Only when one of the engineering team read an article in a professional journal, did they realise that the problem might not be the system, but the environment. They soon observed that the system's failures coincided with the operation of a large drawing copying machine, which was injecting switching transients onto the ring main.

(Furse Electronic Systems Protection Handbook, 1996, page 15, www.furse.com.)

More on this topic…..

Transient faults *(in computer systems)* are triggered by environmental conditions such as power-line fluctuation, electro-magnetic interference, or radiation. These faults rarely do any lasting damage to the component affected, although they can induce an erroneous state in the system. According to several studies, transient faults occur far more often than permanent ones, and are also harder to detect.

Curiously, most computer failures are based on either software faults or permanent hardware faults, to the exclusion of the transient and intermittent hardware types. Yet many studies show these types are much more frequent than permanent faults. The problem is that they are much harder to track down.

*(Taken from "*Fault injection spot-checks computer system dependability*" by J V Carriera, D Costa, and J G Silva, IEEE Spectrum, August 1999, pages 50 and 51, www.spectrum.ieee.org.)*

63) Radio and radar transmitters interfere with early electronic flight control systems

Earlier analogue flight control systems have experienced malfunctions when overflying radio/radar transmitters—the new generation digital systems are very much more robust and can meet the very stringent EMC requirements.

*(Taken from "*Fly by Wire*" by Dick Collinson of Marconi Avionics, Computing & Control Engineering Journal, IEE, August 1999 page 152,www.theiet.org.)*

64) PC EMC compromised by non-compliant components

Computer manufacturers and others are finding it impossible to meet the EMC Directive because of non-compliant CE marked motherboards and power supplies, according to test house EMC Projects. The company tested 12 different motherboards for a client recently and found that every one of them failed to meet EN55022 limits, according to the company's MD Mike Wood. Failures ranged from a few dB to 20dB over the limit line. None was accompanied by instructions about how the boards should be installed to meet EMC regulations. "I feel very sorry for companies trying to meet standards when they use these boards," Wood said. "It is almost impossible for them to comply." He pointed out that any manufacturer relying on CE marked components to justify compliance without testing is likely to have severe problems.

(Approval, Jan/Feb 99, page 5)

Talking to a representative of Intel Corporation (UK) of Swindon about this general issue in 1998, he said that they always tested their motherboards to make sure they were EMC compliant in a variety of different manufacturers' PC enclosures, and that this took approximately two weeks. He claimed that this was one reason why none of the "hottest" machines reviewed in the computer trade press used Intel motherboards – given the fast pace of the computer industry, taking the time to properly qualify a motherboard meant taking second place in the performance stakes to those who were less careful of their legal and ethical obligations.

(Keith Armstrong, Cherry Clough Consultants, October 1999)

65) Investigations into possibility of cell phones interfering with implanted medical devices

According to the Cellular Tele-communications Industry Association's web site www.wow-com.com: researchers have found that analogue phones have no effect on pacemakers, although some digital phones do. Already, doctors advice pacemaker wearers to exercise caution around electromagnetic devices such as MRI machines. Digital phones should be approached in the same way.

Wireless Technology Research Ltd conducted tests involving over a thousand pacemaker patients. They found no clinically significant interactions with the phone in the normal position at the ear. Some interference was noted in 20% of the tests with the phone 6 inches from the pacemaker. But even then, only 6% were clinically significant. Regular operation resumed once the phone was removed. The Food and Drug Administration (USA) believes pacemaker wearers should avoid placing phones next to the implant, as in shirt or jacket pockets. When using the phone, patients should hold it to the ear opposite to the side of the body where the pacemaker is located.

Other cardiac patients use implanted cardiovascular defibrillators (ICDs). The University of Oklahoma's Wireless EMC Centre investigated the effects of all the analogue and digital wireless phone technologies operating in the US and Europe on ICDs from four manufacturers. No interactions were found between phones that operate in the 1800 and 1900MHz bands.

Only one unnamed company's ICDs were affected, and these effects were only caused by TDMA-11 Hz which is only used in specialised operations, and even then no permanent ICD reprogramming occurred. Still, doctors say that additional research is necessary, and researchers say that ICD patients should follow the same guidelines as pacemaker wearers.

(Extracted from Electronic Design magazine, October 18th 1999, page 32H, www.elecdesign.com.)

66) Twenty-eight examples of interference with medical devices

During the past decade, the U.S. Food and Drug Administration (FDA) has received more than 28 medical device reporting incidents of adverse interactions between medical devices and electronic article surveillance (EAS) systems, metal detectors, and security systems. Several case reports and four peer-reviewed studies document adverse reactions between EAS systems and implanted pacemakers, implanted automatic cardiac defibrillators, implanted neurostimulators, and other ambulatory medical devices.

Anecdotal reports and newspaper articles suggest that many more device interactions have occurred and gone unreported. Each year millions of people enter establishments protected by EAS systems. Because more people are using electronic implants and ambulatory medical devices, adverse interactions with EAS systems are of increasing concern.

(Extracted from an article in Compliance Engineering magazine's European Edition, September/October 1999, Page 32, www.ce-mag.com. The article does not draw any conclusions for wearers of implanted devices in the way that item 65) above does.)

(Editor's Note: The number and variety of implanted medical electronics devices is rapidly increasing. Stevie Wonder (the musician) is apparently soon to receive an artificial retina chip. Some very serious people are talking about implanted personal enhancements which are not for medical purposes. EMC takes on a whole new dimension when parts of your body or mind can suffer interference from common electronic technologies.)

67) Digital TV broadcasts interfere with critical medical telemetry

The Critical Care Telemetry Group submitted a petition document (to the USA's FCC), ET Docket 95-177, 10/97 covering new channels from 470 to 668 MHz for powers of 200,000 µV/m at 3m at the same time as the digital TV group submission. This resulted in some confusion and a case where in March 1998 at Baylor University Hospital some medical devices failed due to the DTV broadcast. The FCC and the FDA produced a fact sheet stating that the DTV operators must co-ordinate with the regional hospitals before broadcasting. (Details can be found on the FCC web pages, http://www.fcc.gov.

(Extracted from ERA Technology's Safety and EMC Newsletter, Supplement to Issue 47, October 1999, page 12, http://www.era.co.uk/Services/safety_and_emc.asp. This was reporting on a paper by Art Wall of the FCC presented at the IEEE's International EMC Symposium in Seattle, August 1999)

68) Plane crash nearly caused by portable CD player

In early February a DC-10 was entering its final landing approach at New York's JFK airport when it suddenly banked sharply to the left, nearly causing a crash. NASA and FAA experts concluded that the plane's flight controls were upset when someone in first class turned on his portable CD player. Apparently, newer planes are more heavily computerised and vulnerable to interference. Of particular concern is interference to frequencies used by the VOR (Visual Omni-Range) network, because flight control systems use these navigation beacons for autopilot operation and instrument landing.

(Taken from Compliance Engineering Spring 1993, page 92, itself commenting on an article in Time, Feb 22, 1993, www.ce-mag.com.)

69) Use of CD players banned by some airlines

With reference to Lufthansa's "weird" ban on CD-ROM drives (Letters, 28 March, p.64), the airline is probably extending an existing ban on personal CD players to computers. In the only documented case of interference from personal electronic equipment that I am aware of, an early CD player jammed the instrument landing system on an airliner in the mid-1980s. Because CD players are optical devices, some of the cheaper models did not include any shielding against radio-frequency (RF) interference from the logic devices in their controllers and were therefore quite noisy in the RF bands. *(Allan Gibson)*

In the feature "Do portable electronics endanger flight?" in IEEE Spectrum (September 1996), the reason given for the ban on equipment containing CD players is that "portable compact disc players have an internal clock of 28MHz", which "produces harmonics at 56, 84, and 112MHz – and 112MHz is a VHF aircraft navigation channel" for aircraft. *(Kevin Connolly)*

(These two items both appeared on the same page (56) in New Scientist 25 April 1998, www.mewscientist.com.)

70) Airline check-in desks ban mobile phones

Earlier this year, at Paddington railway station in London, I saw this sign on the door of the airlines' check-in area (operated by BA, American Airlines and British Midland) for customers travelling by rail (Heathrow Express) to the airport: "Please do not use mobile telephones in the area as it interferes with the equipment." (I'd love to know more. I'd speculated -- wild guess! -- that it was US-built check-in equipment that had not been tested for immunity to GSM phones...).
(from Glyn Garside, Director, Engineering Services, Adept Technology Inc., San Jose, California.)

Reply from Jim Rackham of Warwickshire Trading Standards (one of Trading Standards' four EMC Specialists): If the use of a mobile phone is likely to cause any risk to Health and Safety, then the business would have a duty to warn anyone entering the premises not to use it. On a more general note as shops are usually on 'private property' then the owners would have the right to lay down reasonable conditions on what actions were acceptable within the premises. If in certain circumstances mobile phones could interfere with equipment then it might be reasonable for them not to be used - some equipment could still predate the regulations. However, as installations should comply with the protection requirements and if it is reasonable that mobile phones could be used in the vicinity of CE marked equipment, that equipment should be reasonably immune from their interference.

(From Keith Armstrong of Cherry Clough Consultants): An EMC specialist from a major IT company told me that their computer systems only achieve 1V/m immunity although built from equipment that individually meets 3V/m. 1V/m is equivalent to a GSM hand-portable at around 5 metres, in a strong signal area without reflections from nearby metal structures. In weak signal areas (or standby mode) with no reflections, this would instead be around 7 metres. For this reason they generally ban the use of cellphones and walkie-talkies in the computer rooms they build.

71) Robot Wars interference problems

The robots used on the Robot Wars TV show apparently suffer terribly from interference. They are radio-controlled (R/C), often using hobbyist gear. Here are some comments extracted from the "Robot Wars: Tip Swap: weapons idea centre", soon after a robot ran amok and injured someone. The 'failsafes' they are talking about are supposed to shut down all robot activity except when valid R/C is established. *(From Bill Armstrong of PC Help.)*

(Saturday, January 8, 2000) ……Despite what the Reg's state hardly any of the failsafes on the robots were in a working condition. Remember that an awful lot of robots were suffering from radio interference problems, this I find odd, as personally all the robots that have been built here in my workshops ……. have never had a problem. ….. As for the question of failsafes, most of them are

definitely not failsafes and don't work. ……..one common problem on lots of commercial units is because the unit tries to detect an output pulse from the receiver, this works well in a normal environment but in studio conditions this is not the case, interference can (and will) cause 'spikes' on the output and it will assume that is the correct signal and fail to shut it down. Some of the more expensive models actually measure the pulse width and if it falls outside the normal pulse width they then fail safe. …….*(Sunday, January 9)* In my opinion, the biggest safety problem is with the failsafe system. Having run 27MHz R/C cars for years, I am used to how easily control is lost even in friendly RFI/EMI conditions. Most people use commercial RC aircraft failsafes (the little orange thing), which is fine when you are flying a plane outside, in friendly EMI conditions, and signal is completely lost (e.g. transmitter battery fails)…..They are not meant to deal with conditions of huge RFI/EMI interference present at Robot Wars - indeed our electronics guy laughed at the simplicity of the circuit when he took apart the failsafe we bought. It would bypass the majority of interference, and render the robot uncontrollable (and unpredictable). ….Also I have to suspect the method of testing at the auditions. According to ….. the test is simply to switch off the transmitter - and if nothing happens, then the robot passes. But aren't the auditions held in a quiet warehouse, with friendly RF (i.e. little interference), making them totally unrealistic? ……. *(Sunday, January 9)*….the only problem is that a failsafe on some robots may be irrelevant. There are plenty of home-made speed controllers out there with home-rolled micros running the show that could go rogue regardless of whether they have an input at all. Even if PCM is used *(for the R/C)*, there are some being controlled with relays and home made interface circuits that are not too stable irrespective of input. It certainly needs a more technical look at the way people are controlling their motors and weapons…..*(Monday, January 10)* ….The lack of failsafes on weapons channels scares me - I've been near a couple of robots when the weapons channel has fired for no reason…. *(Wednesday, January 12)* …..Just a quick note on the orange failsafes mentioned further back on this thread, I've done some investigating, they come in two varieties. The FS-1 (the one with undervoltage monitoring) works beautifully, the other, the FS-2 is not suitable for use on robots. As mentioned further back, it lets through most interference. There is no external difference in appearance between the two units, other than the number printed on the label…..*(Wednesday January 12)*…The problem we have is when the receiver loses its signal, it holds its last state for 1.5 seconds before it fails safe, i.e. the robot does the last thing it was doing for 1.5 seconds after its signal was lost.

72) Trams fitted with inverter drives interfere with hospital equipment along their route

The Helsinki City Transport (HKL) rolling stock is ageing fast. The most recent trams were built 20 years ago. Hitherto, all auxiliary equipment, such as ventilator fan motors were DC and the maintenance of these units was becoming something of a nightmare. Spares were costly and it was a very labour intensive process keeping them in service.

In each HKL tram there were six ventilation fans with DC motors cooling the passenger compartment, brake resistor, and traction motor. The thinking was that one big inverter supplying six AC motors was going to be cheaper than several smaller inverters supplying one motor each, so a 15kW unit was mounted in the main electrical panel of one of the trams. The existing cabling was retained because of cost considerations and this connected the various motors in parallel. EMC problems very quickly surfaced. Not only was the vehicle's own radio system badly affected, but –crucially – third party electrical equipment also suffered interference, including that of a hospital on the tram's route.

The problem was solved in the end by siting individual inverters close to the motors they controlled.

(*From an article by Les Hunt in dpa Magazine, March 99, Drives Supplement page 29,* www.dpaonthenet.net.)

73) Solar storms black out Canada in 1989

Every 11 years violent storms on the surface of the Sun cause massive amounts of energy – in the form of protons and electrons – to be thrown out into space. After a few days, this energy reaches Earth, interferes with the planet's magnetic field and generates huge currents – particularly in the polar regions. These induced currents can subsequently induce massive surges in *(power distribution)* transmission lines, damaging transformers and causing high-amplitude harmonics. In the space of just 2 minutes in March 1989, six million people in Quebec, Canada, suffered a complete blackout because of a severe storm from space. In the UK the problems were less severe, but some were experienced.

(From Electrical Review, 20 July 1999, www.electricalreview.co.uk.)

The first space weather prediction system for electric power grids has been completed in the UK. The main problem for networks is losing control of voltage regulation, but with the new system certain regions can be highlighted as being particularly at risk and necessary precautions taken. So far in Solar Cycle 23 – the name for the current bout of activity – longer-term forecasts have given two clear warnings of potential disruption.

(*From Electrical Review, Vol. 233 No 5 p 10, www.electricalreview.co.uk.)*

74) Walkie-talkie interferes with ship steering, causes minor collision

There was a minor collision between a supply vessel servicing a semi-submersible offshore oil and gas installation. The vessel experienced a sudden power increase brought on because of interaction between radio signals from a portable VHF radio and the joystick control. This caused the joystick to execute commands not requested by the operator and resulted in contact between the vessel and the installation. The interaction caused minor damage (though it could have been far worse).

The incident occurred outside UK waters and was reported in a safety notice issued by an offshore operator. The safety notice was seen by an HSE inspector on a bulletin board on an offshore installation, dated 30 September 1999, which referred to the incident as having happened 'recently'.

(F*rom Simon Brown of the HSE, 14th and 15th February 2000.*)

75) EMI problems and shipping

"NOTING the growing number of problems experienced with equipment that is susceptible to electromagnetic interference, which can result in dangerous situations,….."

*(Extracted from IMO Resolution A.813 (19):1995, "*General Requirements for EMC for all Electrical and Electronic Ship's Equipment*")*

76) Class D amplifier launch delayed by EM emissions

National Semiconductor plans to begin shipments of Class-D audio amplifier ICs before Christmas. The delay of the launch, which was first reported by NE in June this year, has been attributed to the design of the development board. Class-D amplifiers, while efficient, require careful layout to prevent EMC problems from the internal 50kHz oscillator.

(*From New Electronics magazine, 14th December 1999, p 8, www.newelectronics.co.uk.*)

77) Faulty central heating thermostats can interfere with radio and TV

Faulty thermostats can cause annoying interference to radio and TV broadcast reception. They cause short bursts of interference that may recur at intervals. Thermostats in central heating systems, fridges or freezers switching on and off have all caused interference problems. Our experience shows that the thermostat found in the central heating system is most often the source of the interference. Often the offending thermostat is found in the house receiving the interference, although the agency is aware of cases where the source of the interference was some distance away.

(*From the Radiocommunication Agency's publication RA 272 (Rev3) May 1999, http://www.ofcom.org.uk/radiocomms/ifi/glines/interference/148207.*)

78) EMI dangers of using mobile phone handsets while driving

Millions of motorists are risking their lives every time they use mobile phones while driving. New research has revealed (that) signals sent from mobiles can disrupt sophisticated electronic control units fitted in most modern cars. And it is feared that in some instances this could scupper vehicles' braking and engine systems. One major manufacturer has also warned that the transmissions from mobiles could trigger air bags fitted to the car.

The alert over making calls in the car was given by the AA following research into the problem. The motoring organisation is now urging drivers to ensure they stop their cars before making any calls. Last night an AA spokesman said: "It is the same as aircraft operators asking people to switch off their mobiles while on a plane. The mobile is transmitting all the time and there is the possibility of interference with electronics in the car. You might get a misfire or your braking system might not operate. The answer is to only use the phone when you are stationary or to install an outside aerial."

(*From an article by Bill Caven in the Daily Record, 10th Jan 2000, p 23. Also see an article by Ian Fletcher in the Sunday Mirror 9th Jan 2000, p 9. Both were sent in by Dai Davis, then Head of IT, Communications and New Media Group at Nabarro Nathanson, now with Brooke North LLP, Solicitors, www.brookenorthllp.co.uk.*)

Five examples of EMI from Art Wall of the FCC. *Items 79 through 83 below are taken from comments by Art Wall (Associate Chief of the Policy and Rules Division of the USA's Federal Communications Commission) during an EMCTLA seminar on FCC requirements on the 18th May 2000, www.emctla.co.uk.*

79) Radio remote controlled garage door openers are short-range devices which use a part of the spectrum also used by the military. People got fed up with their garage doors opening every time a military jet flew over, so the manufacturers added coding to their signals.

80) Retail shops use anti-pilferage devices (the hoops that are to either side of their doors), which operate in the USA between 510 and 1705 kHz. The goods to be protected have a small label stuck on them that resonates at the appropriate frequency and disturbs the field produced by the hoops, allowing detection. It was found that heart pacemakers were susceptible to the anti-pilferage fields, so pacemaker manufacturers had to improve their designs to make them less susceptible.

81) There used to be a lot of problems with light dimmers interfering with AM broadcasts. The manufacturers added suppression to their products to satisfy customers and maintain sales levels (and not because of any regulations or standards).

82) A plywood laminating machine in Kentucky used 1.6 MW at 6 MHz to speed up the drying of the laminating glue. Operators removed a door which had a perforated metal screen so that they could see the inside of the machine better – subjecting themselves to hazardous levels of RF field. (Incidentally, Art claimed that more RF energy is used world-wide in manufacturing, for processing materials, than is used in broadcasting.)

83) Diathermic knives are electro-surgical units used by surgeons to cut tissue whilst sealing blood vessels using RF energy. Although they pass the FCC limits of 10 μV/m at 1 mile distance, they can generate 1000 V/m (1kV/m) at the surgeon's head.

84) **Mobile phones can cause interference to aircraft electronics**

Evidence of interference to aircraft had been anecdotal, with many reports by pilots suggesting that mobile phones were the source of the problem. The UK's Civil Aviation Authority (CAA) safety regulation group conducted tests on the ground on a Virgin Atlantic 747 and a British Airways 737.

The conclusion was that "transmissions made in the cabin from portable telephones can produce interference levels that exceed demonstrated susceptibility levels for aircraft equipment approved against earlier standards." Faults attributed to mobiles included noise of the flight crew headsets and false triggering of warning signals, which could have a 'cry wolf' effect meaning crews might ignore a real warning.

(*Electronics Weekly, May 31 2000, page 2, www.electronicsweekly.com*)

85) **CATV system re-radiates interference**

In a recent radio interference case, a cable television (CATV) system was found to be causing radio interference. Upon investigation it was found that this was due to the CATV system picking up the interference from a buried cable in a parallel duct (and re-radiating it).

(*Peter Kerry, "*EMC in the New Millennium*" IEE Electronics and Communications Engineering Journal, April 2000, Page 47, www.theiet.org.*)

86) **Fluorescent lamps can interfere with mobile phones**

People have learned to live with problems such as their mobile phone not working near the fluorescent light.

(*Peter Kerry, "*EMC in the New Millennium*" IEE Electronics and Communications Engineering Journal, April 2000, Page 47, www.theiet.org.*)

87) **Spikes can cause insulation breakdown even at low levels**

I was intrigued by the article by Prof. Yacamini *et al.* Relating to overvoltages at the terminals of downhole pumps supplied by variable speed drives (February 2000 PEJ, p.29). In the 19602 there was a series of faults on a group of cross-bonded 132 kV cables in the London area which were never satisfactorily explained, despite extensive on-site measurements using foils embedded in the joints, the last fault occurring shortly after the measuring instruments had been disconnected. These faults were located in joints at about one-quarter or half-way along the routes, successive faults occurring at the same joints, despite very careful repair by an experienced cable jointer. No serious overvoltages were measured.

Much investigation into surge voltages on cables and overhead lines has shown how steep-fronted waves can impose overvoltages, particularly at discontinuities such as exist at motor terminals. The continual overstressing of insulation by the spikes every half-cycle can lead to progressive failure, even if the overvoltage is not sufficient to cause immediate breakdown.

(*H. J. Langley, Letters to the Editor, IEE Power Engineering Journal, April 2000, page 48, www.theiet.org*)

88) Aluminium smelter's underground cables interfere with power metering

Working for Ferranti in the mid 1970s, we had a problem with the power metering in a power station near Loch Lomond. Every now and again (once every few weeks) we got totally ridiculous readings. Neither the readings or their occurrence was predictable or consistent. We tried various earthing schemes and surge suppression, but then discovered that there was an aluminium smelter close by – and its huge power cables ran 3 feet underground the power station's control room. The fields from these cables were powerful enough to magnetise wristwatches. The problem was solved by filtering the electronics of the kWh meters.

(From *Dave Dunn, Senior Applications Engineer, IMI Norgren, Manchester.*)

89) US$1.5 billion computer downtime caused by power quality problems

In 1994, studies revealed that the total cost of computer downtime to U.S. businesses had climbed to an all-time high of over $3 billion. "Power-related problems" was the number one cause of computer downtime, amounting to over 45% of occurrences and resulting in losses of $1.5 billion. Many of the power-related problems could be traced to the most basic element of the computer network: the wiring and grounding of the host building.

(*From "Networking Equipment and Downtime: Caught in the Middle" by Tony DeSpirito, Electronic Design magazine, April 1997, pp 42-48. We wonder what the 1999 figures were.*)

90) xDSL technologies could increase radio noise floor

Recent developments in broadband data access methods over existing telephone or mains wiring will cause unintentional RF emissions which may adversely affect the established radio noise floor.

(From report AY3525 produced by York EMC Services for the Radiocommunications Agency on the effects of ADSL, VDSL, and power line technology such as HomeLAN. This and many other interesting documents may be found by hunting around the (legacy) Radiocommunication Agency's website hosted on Ofcom's site at: http://www.ofcom.org.uk/static/archive/ra/rahome.htm.)

91) Electromagnetic 'bombs' – the perfect weapons?

It sounds like the perfect weapon. Without fracturing a single brick or spilling a drop of blood, it could bring a city to its knees. The few scientists who are prepared to talk about it speak of a sea change in how wars will be fought. Even in peacetime, the same technology could bring mayhem to our daily lives. This weapon is so simple to make, it wouldn't take a criminal genius to put one together and wreak havoc. Some believe attacks have started already, but because the weapon leaves no trace it's a suspicion that's hard to prove.

The perfect weapon is the electromagnetic bomb. The idea behind it is simple. Produce a high-power flash of radio waves or microwaves and it will fry any circuitry it hits. At lower powers, the effects are more subtle: it can throw electronic systems into chaos, often making them crash. In an age when electronics finds its way into everything bar food and bicycles, it is a sure way to cause mass disruption.

(*From* "Just a Normal Town..." *the cover story in New Scientist's July 1st 200 issue, pp 20-24. The article goes on to quote a researcher who claims that modern computers and their systems are easier to crash with EM weapons than older models.)*

Seven examples of EMI from Anita Woogara. *Items 92 to 98 below are taken from "*Study to predict the electromagnetic interference for a typical house in 2010*" by Anita Woogara, 17 September 1999.* This and many other interesting documents may be found by hunting around the (legacy) Radiocommunication Agency's website hosted on Ofcom's site at: http://www.ofcom.org.uk/static/archive/ra/rahome.htm.

92) Hearing aids operate between 200 – 4000Hz. Manufacturers have to comply with the Medical Devices Directive and the IEC118-13 'Immunity of hearing aids from interference with cellular phones'. However, due to the interference experienced, it is not felt that these are adequate for those (hearing aid) users who also wish to use items such as mobile phones.

93) Mobile phones and passing taxi radios have been known to interfere with Anti-skid Braking Systems (ABS) and airbags, causing drivers to lose control of the car.

94) Railways cover most of the country and can pass quite close to residential buildings and hence affect the equipment inside them. Additional immunity constraints are placed on the users of information technology equipment in the near vicinity. However, it is unclear how suppliers know that their users will be situated near railway systems. (*The study makes similar comments about tram systems, and the problem is their low-frequency magnetic field emissions.*)

95) Mobile phones are becoming so popular that in America it is difficult for people to have a phone call without being cut off due to interference. This is leading to people suing mobile phone companies for not providing the advertised service.

96) Cochlea implants are small electronic devices placed under the skin to assist hearing. Unfortunately, they are prone to interference, such as the security checks at shop entrances and airline security, which can damage an implant. People with cochlea implants have also been told not to use mobile phones.

97) The (UK) government is trying to encourage people to use public transport. An incentive to use public transport would be punctuality. BT is investigating an idea which would enable the time of arrival of the bus to be checked by using either the web or a mobile phone or pager. The bus would be fitted with a GPS tracker so that its position could be monitored. This technology would be useful but in large cities GPS on buses might not be that reliable, due to the interference.

98) Electronic tagging takes the form of a small bracelet worn around the wrist or ankle. Presently the (UK) Home Office is the main user of electronic tagging, keeping track of prisoners in the community. Children could be fitted with a tagging bracelet before setting off to walk to school and parents could be notified if the child wanders off the route, via mobile phone or pager. The problem with this would be when the GPS signal was interfered with and incorrectly showed that the child was off the route. This interference is likely to take place in cities. These problems already occur with prisoner tagging. (*For more on GPS problems see Banana Skin No. 29.*)

99) EMI claimed to be a possible cause for crash of TWA800

Elaine Scarry has found some common threads in the crashes of TWA 800, Swissair 111, and Egyptair 990, that indicate a significant possibility that they were brought down by electromagnetic interference from military aircraft or ships on exercise. This possibility does not appear to be under consideration by the accident investigators for these incidents.

Read her articles in the New York Review of Books by going to http://www.nybooks.com and then searching their archives using the author's name: Scarry.

100) My neighbour has had a new heart pacemaker fitted – every time he makes love my garage doors open

(Attributed to Bob Hope, 1975. We try to find amusing or off-beat items for our 100th Banana Skins.)

101) Poor power quality costs businesses in Europe €13-20billion a year.

This estimate is from the European Copper Development Association, and is the first attempt to pin down the cost in Europe of voltage deviations, transients, interruptions, and harmonics, says the organisation. These problems are increasing because of the growing use of equipment such as switch-mode power supplies, variable-speed drives, and high-frequency lighting, it adds.

The use of such polluting equipment means that 70-80% of power quality problems are caused by operations on sites, rather than by external effects, says the institute. Problems produced by poor-quality power include glitches in computers, burnt-out motors, failed transformers and fires caused by high neutral currents.

(*From Electrical Review, 4th July 2000, page 3, www.electricalreview.co.uk.*)

102) Harmonics from low-voltage lighting can cause overheating

In the lighting industry, simple switch-mode power supplies with AC outputs, often called "electronic transformers", are used increasingly to operate 12 volt lamps from the mains supply. In a retail store 50-100 of these units each rated around 50W would not be uncommon.

Most of these devices claim to meet the EMC Directive individually and are CE marked. However if a number of these devices are operating in one location, then their total emissions can be shown to exceed the limits for both RF and harmonics, sometimes by a large margin.

There are already instances of other equipment malfunctioning, and of sine wave distortion causing conventional transformers to overheat (due to enhanced core losses). I have experience of a building which had recently been fitted with about 50 off 50W "electronic transformers", the harmonic emissions from which so distorted the mains supply waveform that conventional transformers powered from the same mains distribution overheated.

Clearly, this is not just an EMC issue, but a significant safety concern. But my experience so far is that lighting equipment manufacturers, on the whole, don't seem to understand this significance of this problem, and that installers could not care less.

(*From Fane Murray, 4th September 2000.*)

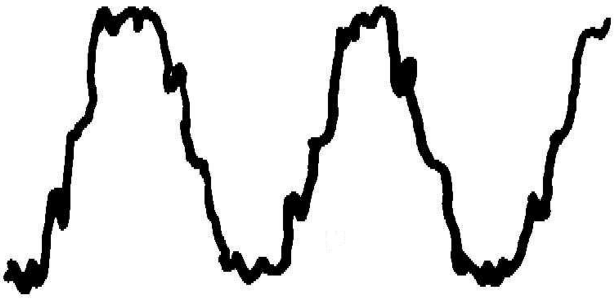
103) Panel Building Industry 'hazy' about EU Directives

Another common problem is that of knowledge of Directives. Some contenders appear to have a hazy understanding of the EMC and LV Directives for example.

(*Stuart Wetherall, Publisher, writing about the 'Panel Builder of the Year Awards in Panel Building Magazine, September 2000 pages 12 to 20.*)

104) Poor mains waveform quality in Israel

Just a note of thanks for your illuminating series in EMC Journal. As an electrical layman I found them helpful when trying to analyse my 10-year dissatisfaction with the Israeli brand of mains, which seems to contain harmonics from 9th upwards (see the sketch below).



Not only does the mains supply show obvious clipping, ringing, crest flattening and zerovolt crossover distortion, but the thick line (represented by my crude felt-tip trace) resolves itself into stable "carrier wave" oscillations at 10kc to 10MC (which is why my AM radio gives off sounds like a buzz-saw at BBC World and other frequencies). "What in the developed world would constitute a road-hazard, in the developing world often has to serve as the road".

(*From Nick Maroudas PhD (ChemEng) DIC, 2nd October 2000*)

105) Interference with racing car video

Video cameras in racing cars provide exciting live pictures for TV, but the image is often spoilt by interference.

(*From New Scientist, 30th September 2000, www.newscientist.com.*)

106) 1998 Grand Prix suffered interference

In the lead-up to the 1998 Grand Prix, electrical storms caused a spike in the power supply which sent major ripples across the facility's feed lines – crashing all race control computers. After the ensuing chaos, the problem was rectified and the race proceeded as scheduled but the experience left the Silverstone management adamant that this type of disturbance would not be repeated at future events.

(*From "Grand Prix UPS weathers the storms", Electrical Products September 2000 page 34, Electrical Products & Applications: www.imlgrouponthenet.net.*)

107) Twinkling antennas cause high levels of emissions

'Twinkling antennas' are a recent innovation in the mobile phone market. They incorporate one or more Light Emitting Diodes (LEDs), which are intended to illuminate when the mobile phone is transmitting. Reports from Mobile Phone companies using the 1800 MHz band have highlighted cases of interference from 900 MHz GSM mobiles. It has been suggested that the non-linear characteristics of the LEDs will cause a transmitting twinkling antenna to radiate harmonics.

(Tests carried out by the Radiocommunications agency on two 900 MHz cellphones fitted with twinkling antennas showed that…..) the ERP of the second harmonic…..exceeded the ETS 300 577 maximum.

(*From EMC Matters, published by Brian Jones: emc@brianjones.co.uk. The full report of Project 564 and many other interesting documents may be found by hunting around the (legacy) Radiocommunication Agency's website hosted on Ofcom's site at: http://www.ofcom.org.uk/static/archive/ra/rahome.htm.)*

108) Industrial microwave oven interferes with cell phone base station

In the UK 886 to 906MHz has been allocated as a band suitable for the operation of Industrial Scientific and Medical (ISM) equipment. ISM machines are at present allowed to emit 120dBμV/m (i.e. 1Volt/metre) measured at 30 metres from the wall of the building housing the equipment over this frequency range. This presents a problem as it occupies part of the band allocated to mobile phone operators.

The main users of the ISM band are organisations operating industrial microwave ovens. The ovens are used in food production although other uses such as vulcanising rubber are also on record. High power magnetrons are used as the source of microwave energy, the magnetrons are designed to operate at 896MHz. For process purposes the ovens are normally conveyor fed.

Consequently depending on the size of product being treated a large aperture exists at each end of the oven allowing relatively high levels of microwave energy to be emitted. The channel 30 mobile to base-station frequency coincides with the magnetron centre frequency. ……. The second oven at Griffith laboratories is of particular interest as the emissions are known to disturb the operation of a base station located in the vicinity.

*(Extracted from: "*Industrial Microwave Oven (ISM) Emissions and Mitigation Techniques*", Dr D Welsh, Proceedings of EMC York 2000, 10-11 July 2000, www.yorkemc.co.uk.*)

109) Australian telco has problems with inadequate immunity to EMI

The current Australian regime (for EMC compliance) only covers emissions requirements, but there has been extensive discussion about whether immunity should also be made mandatory. …..a submission from a major telecommunications network company (Telstra) outlined difficulties it has experienced in dealing with customer equipment susceptible to interference.

The ACA mandates interoperability, safety, and emissions standards but telecoms carriers have little control over the EMC quality of equipment connected to their network.

*(From Chris Zombolas of EMC Technologies Pty Ltd: "*Australian framework comes under review*", Approval, Sep/Oct 2000 pp7-8.)*

110) EMI problems with early electronic ABS

When Ford began the development of an electronic anti-lock braking system in 1982, their engineers noted certain "concerns" about its behaviour when subjected to high levels of interference. (*Ed: Such as those created by mobile radio transmitters of around 100W, either on-board or mounted on nearby vehicles.*) Not only was it liable to fail, bad enough if a driver had come to rely on it, but it could do so in a particularly nasty manner, deactivating the system.

*(Tom Shelley: "*Screening protects anti-skid brakes*", Eureka May 1987, pp36-37, www.eurekamagazine.co.uk.)*

111) High field strengths near vehicles' on-board transmitters

Fields in and around vehicles with onboard transmitters (at the maximum legal power of 110W) range mostly between 10 and 300 V/m, with some exceptions. Field strengths in and around vehicles adjacent to vehicles with transmitters range mostly between 5 and 100 V/m.

*(From "*How does EMI affect automotive electronics?*" Microwaves, April 1980, pp 96,www.mwrf.com.)*

112) Mobile phone use not recommended on aircraft

I'm tempted to think your article about mobile phones on aeroplanes was itself a flight from reality (19 August, p 18). The problem with cellphones is that they radiate at moderate powers which are capable of upsetting the operation of any of the semiconductors in any of the electronic systems in the aircraft.

Try this little experiment: phone a friend using your POT (plain old telephone landline) and then phone someone else using your cellphone. Hold the cellphone at various distances from the POT handset and its cables and see how far away it has to be before you can't hear the "blippety-blip" noises on the POT. According to the reported statements in the article, the possibility of interference in these little experiments would be "very low" when in fact it almost always occurs.

*(Keith Armstrong: "*Mobile menace*", letters, New Scientist, 9 September 2000, www.newscientist.com.)*

113) Mobile phones cause interference on the flight deck

As a captain of a brand new Boeing 737 aircraft, I can assure readers that the effects of mobile phones are very noticeable on the flightdeck. The chief problem is a series of rapid beeps from the handset when it "checks in" with a base-station. The handset does not need to be making or finishing a call to perform this function, it only needs to be switched on. The interference manifests itself as a loud and annoying interference, but since some of our navigation equipment works on the same frequencies, interference with navigational capabilities cannot be ruled out.

Another more worrying source of cellphone interference was not even mentioned in your report – mobile phones in air-traffic control centres. We had a case the other week on a Spanish sector where a mobile phone in the air-traffic control centre was continuously trying to check in with its base station and the interference was totally blocking the frequency.

Mobile telephones are an airborne menace, but you have to ask why aircraft systems are not better protected against interference in the first place. Thunderstorms can saturate our old-fashioned (but new) AM radios with static, and the ADF navigation equipment will direct the aircraft straight towards the nearest thunderstorm instead of the airfield. Is this really the high-tech field of aviation?

(*Ralph Ellis: "*Mobile menace*", letters, New Scientist, 9 September 2000, www.newscientist.com.*)

114) HV transmission lines cause shock hazards for nearby swimming pools

In general, an above ground pool is 6 to 12 times more hazardous than an in ground pool. Of the cases investigated, the majority of hazardous situations associated with pools were found to be above ground pools in close proximity to transmission line towers. It was recommended that all pools of the above ground type in close proximity to transmission lines be removed immediately.

(*D.J.Woodhouse, K.D Newland, W.D. Carman, all from Energy Australia: "*Development of a risk management policy for transmission line easements*", ERA's Earthing 2000 conference, 21-22 June 2000, pp 6.7.7, www.era.co.uk.*)

115) Radio transmitting station interferes with railway train brakes

A European train operator had a problem on a section of track near a radio transmitting station. When a certain type of locomotive was passing by the radio station its main circuit breaker would open, causing it to brake. It was found out that the temperature sensors within the traction motors picked up the radio signal. The cables to these sensors weren't screened. A modification to this would have been very expensive as the sensors are mounted within the winding of the motors.

The solution chosen was to increase the time window for the signal to be above a certain limit before the control would take action. Due to the long time constant of the thermal behaviour of the system, this solution was acceptable and sufficient.

(Sent in by Jennifer Cortese, Melbourne, Australia, December 2000)

116) Diesel engine spurious start-up caused by taxicab transmitter

I was lying on my back underneath a diesel engine (part the emergency power generator of a hospital) with the sump off, doing some work on the bearings. There was not a lot of room between the engine and the floor. The diesel generator was turned off, that is to say the OFF pushbutton on the control panel had been pressed and the controlling PLC's display showed the OFF condition.

Suddenly, the diesel's starter motor operated and the engine began to run, with the crankshaft whirling around a couple of inches above my nose. Very cautiously, I slid out from underneath. I discovered that a 'bush taxi' that called at the hospital was responsible. These bush taxis had extra powerful radio transmitters fitted, so they could stay in touch with their base when very far away in the bush. Keying the powerful transmitter at the hospital entrance created enough interference for the generator's controlling PLC to think it had received the start command.

(*Attendee at an EMC seminar in Sydney, Australia, November 2000.*)

117) AS$8 million machine spurious start-up caused by transients

We were close to finishing the construction of an eight-million-dollar mining machine in a cavern in Australia. The operators of the mine had a central control room from which they wished to be able to exert manual control over any machine in the mine, even though the machines were automatic or had local control. Accordingly, the mine operators ran their own cables from their control room and connected them to spare inputs and outputs on the PLC for each new machine, also making the necessary software modifications themselves.

Suddenly, while we were standing by the machine, it started up of its own accord. Luckily, no-one was working on it at the time, although they could have been, but it was still a very serious issue as the machine had not yet been filled with lubricant and could easily have been wrecked. It turned out that no special precautions had been taken with the cables from the control room to the PLC, or with the software changes, and a transient interference with the new cables had caused our machine to start up unexpectedly.

(*A different attendee at an EMC seminar in Sydney, Australia, November 2000.*)

118) Spurious start-up of machine with 5 metre blades

I was visiting a company that made cutting machinery for carpet manufacturers. These machines had blades 5 metres wide, and very sharp. Adjusting the blades to get a good cut over the whole 5 metre width involved careful adjustments, and I noticed that some of the engineers would lie under the blade while making these adjustments.

I also noticed that the control panel (which used low-cost PLCs and not safety-critical types) was in 'single step mode' during these adjustments, and not 'locked-out' at its main electrical supply disconnector. I asked the Chief Engineer if they had ever had one of these machines start up on its own when in this mode, and he said that it had been known to happen, presumably due to transient noise on its mains supply or picked up by its cables.

(From an EMC Consultant who wishes to remain anonymous, February 2001)

119) Possibility of UWB interfering with GPS

I just had to write to you about the [November] editorial "Whose spectrum?". It is right on the mark. However, I would like to point out that there is another crucial difference between ultra-wideband (UWB) devices and hair dryers in addition to the list that Charlie Trimble so appropriately collected; if you choose to shield the hair dryer or otherwise filter its electromagnetic emissions, it still functions as a hair dryer!

If in the future, UWB is (heaven help us) given the desired rulemaking, becomes as pervasive as that industry dreams it will, and then is found to jam GPS at large distances, there will be no technical remedy, just a face-off between two competing industries. To follow the thread of your editorial, if we must grant UWB an FCC Part 15 exclusion just because we have a precedent with other emitters in the band, then we are truly facing a spectral "tragedy of the commons".

(*Stephen Lazar of The Aerospace Corporation, writing to the editor of GPS World magazine, Page 6 of their January 2001 edition, www.gpsworld.com/gpsworld.*)

(Editor's note: 'ultra-wideband' radio communications devices use a train of very brief pulses occupying many MHz, even GHz of spectrum simultaneously, using time-domain techniques to distinguish one transmission from another unlike traditional radio that uses frequency domain techniques. Their transmitted spectra look like wideband white noise at relatively low power, and the effect of large numbers of them is to raise the noise floor considerably, to the point where the weak signals from GPS could be jammed. Also see Banana Skins December 1998 issue. The same technology is also capable of being used as a 'personal radar' useful for all sorts of things, such as checking someone's heartbeat without contact, or detecting people through walls. We will no doubt be hearing a lot more about UWB in the future.)

120) How EMC techniques saved hundreds of millions of dollars

The new series of Australian banknotes have a plastic film embedded in them, RF welded into place. When the new bank note production line was first used, the emissions from the RF welder (dialectric heater) upset other printing machines and ruined large numbers of banknotes. They called me in and I fixed the problem, improving their productivity and saving them from burning hundreds of millions of misprinted dollars!

(From Chris Zombolas, EMC Technologies Pty Ltd, Melbourne, Australia, www.emctech.com.au.)

121) Police Frequency Freaks Hospital

Further to confirmation that mobile 'phones can indeed interfere with the navigation systems and electronics on board aircraft, news arrives that the UK's new £2.5 billion national police radio network is being urgently tested amid fears that it will interfere with vital hospital equipment and breath-test and radar speed machines. Until it is checked, police have been told to turn their new radios off in hospitals and near other vital equipment. There could also be problems at airports, ports and even in police control rooms.

The network uses a digital radio system called TETRA, or Terrestrial Trunk Radio. The handsets send out pulses at frequent intervals to the nearest masts, identifying their presence, but the pulses can affect the electronics of some types of equipment. The alarm was raised when Jersey police, who are already using Tetra, reported possible problems with their speed and drink-drive equipment. Scientists at the Defence Evaluation and Research Agency (DERA) have been commissioned to discover the level of interference and what else the radios could affect.

(From: The Times, January 2001, sent in by Harold Smart who saw it in the Royal Institute of Navigation Journal, January/February 2000 issue, www.ion.org.)

122) Interference clouds future of multi-billion police radio project

Police from the channel island of Jersey, which is going through pre-implementation testing of the TETRA technology, is advising its officers to be much more careful about using the equipment than was the case with previous kit. Because of fears of interfering with hospital equipment, the States of Jersey police have imposed tough rules on using equipment and ordered the lowest powered handset available.

The testing also threw up concerns that, according to a statement issued by the Jersey Police, "if a speed detection device suffered external radio interference, it was rendered inoperative". There are also concerns about breath testing devices. According to reports police are being advised that they can only do breath tests 10m from handsets or 35m from more powerful car transmitters. This has raised concerns that the system, the price of which has already been a source of discontent with the old bill, will be turned off in many situations.

The Police Federation has raised concerns that operational effectiveness and even police safety will be damaged, and not improved, by the introduction of the technology. A spokeswoman for the suppliers of the technology, BT Quadrant, said that the equipment used complied with international standards. She compared the equipment to GSM phones which also have to be turned off in hospitals.

(Extracted from an article posted in The Register on 22nd Jan 01 by John Leyden, http://www.theregister.co.uk/content/5/16266.html, sent in by Graham Eckersall, G4HFG.*)*

123) Police radios can trigger positive breath test

If you're ever asked to do a breath test by the police you might do well to insist that they turn off their radios before you blow into their breathalyser. The advice comes from an ex-copper who wrote to us after we printed a story about police concerns about interference from next-generation handsets *(see above – editor)*. He writes: "When at the Metropolitan Police training school, it was taught that PCs should not press the PTT (push to talk) button on the personal radio whilst waiting the requisite forty seconds for the lights to (hopefully) go red. Never. "Oh, no - indeed. Definitely not. Especially if the subject was being 'griefy'. Honest."

He adds that the idea that that a PC might surreptitiously give a quick burst of transmit on his radio whilst his partner was administering the breath test to an uncooperative suspect, was similarly frowned upon. Its worth noting here that, at least in Britain, the actual charging and conviction of drink driver suspects relies on a different test which is administered at police station. Our correspondent explains the technique was used to annoy awkward customers. "This merely gave the opportunity to cause inconvenience, spend time filling out the forms, apologise profusely and sincerely (again, honest) afterwards, give the driver back the keys to his car and advise him where he might find a cab to drive him back to it. At four in the morning. "Oh dear. Terribly sorry, but we are not insured to give you a lift if you are not a prisoner anymore. Sir. No cash on you, then it's a long walk back, in the rain," he added.

Another reader, who worked for the St. John Ambulance, a first-aid volunteer service, recounts a time on duty when he saw a policeman using his radio to trigger a positive result on a breath test. Apparently it was all a bit of innocent fun and the guy was using the trick in a rather strange attempt to chat up a woman he fancied. Our man in the St. John's Ambulance service says that ambulance radios can have the same effects on breathalysers. It's not that we condone drink drivers, but if you're ever pulled up (and assuming you're not too drunk in the first place) now you know what to look out for. Lets be careful out there.

(Article by John Leyden in the Register, http://www.theregister.co.uk/content/archive/16413.html, posted on the 26th January 01, sent in by Graham Eckersall, G4HFG.*)*

124) Pacemaker users get digital radio warning

A reader was taken aback when he took delivery of digital radio handset from Motorola that contained a series of warnings for pacemaker users. The Motorola d700 handsets, which will be used in a Terrestrial Trunk Radio (TETRA) digital communications project, contain recommendations from the Health Industry Manufacturers Association which advise a minimum separation of 15cm between a handset and a pacemaker.

This advice, albeit well intentioned, leads to a number of surprising tips. Pacemaker users should not keep handsets in their breast pockets and furthermore should "use the ear opposite the pacemaker to minimise the potential for interference". It goes on: "if you have any reason to suspect that interference is taking place" with a pacemaker you should "turn the handset OFF immediately" -- that's if you've not been hit by shortness of breath, of course. We gather there's also warnings about hearing aids, "other medical devices", explosives, and a range of other things, which leads our reader to conclude that "it's hardly surprising people are scared of these things".

A health and safety expert at Motorola confirmed the information and pointed out, quite reasonably, that the instructions are part of the training it provides its users to make sure its equipment is used safely. He said that "similar power levels" were used by Tetra and GSM equipment, which means that interference levels were "not horrifically different", though higher, than older analogue technologies commonly in use today by emergency services, the chief market for Tetra.

So, should pacemaker users avoid mobile phones? Well the issue seems to have more to do with the electrical immunity, or lack of it, associated with a particular pacemaker -- whose manufacturers ought to provide concerned users with all the information they need. It makes you think though.

(Article by John Leyden in The Register, http://www.theregister.co.uk/content/2/17357.html, posted on 5th March 01, sent in by Graham Eckersall, G4HFG.*)*

125) People around the globe are fascinated with Bremerton's tale of a bizarre electronic failure

The widespread failure of keyless remote entries on vehicles around Bremerton last week has sparked interest far beyond the local community — thanks to the ubiquity of the World Wide Web and nationally syndicated talk radio. Since the story first ran Saturday in The Sun, it has been broadcast by two nationwide radio programs that focus on bizarre phenomena — "Coast to Coast with Art Bell" and "The Jeff Rense Show." It also has been posted on numerous Web sites, including The Sun's (www.thesunlink.com), and reprinted in other newspapers.

The widespread posting has fuelled a flood of responses from all over the country — and even from as far away as Russia and Croatia. Meanwhile, the strange incident remains a hot topic in West Sound as residents try to solve the mystery and add to the list of impacts beyond the mass failure of remote entry devices. The outage, which went from about 4 p.m. March 21 until about 6:30 a.m. Monday, apparently was caused by interference with the short-range UHF radio signals transmitted by small hand-held keyless remote devices to an unlocking receiver in the vehicle.

The source of that interference remains a mystery, however. The Federal Communication Commission believes the local military presence is "very possibly" the source of the disruption, said a government official familiar with the agency's investigation into the outage. Although Navy officials still insist they can find no link between the interference and USS Carl Vinson's recent return to Bremerton, most responses sent to The Sun reflect a widespread belief that the military presence is to blame for the disruption. They also question whether the interference might have caused other problems — and that still might be occurring.

Some samples of responses:

- An ex-Navy technician wrote: "You know as well as I do that an active electronic countermeasures (ECM) was inadvertently left aboard a ship docked at the shipyard, causing remote car lock devices to be inoperative. That's what 'jammers' are supposed to do. It is not a coincidence that the effect occurred when (USS) Carl Vinson arrived, and then when the sailors went back to the ship Monday and took a good look around, they turned it off."
- A computer buff in Izakovic, Croatia, wrote that electromagnetic emissions from U.S. Navy warships fry his Internet modem whenever they pull into the local harbor. He now is on his fourth modem and suspects that similar emissions caused the interference in the Bremerton area. "Bremerton mystery is not a mystery at all. U.S. Navy has in operation VTRPE radar and IR/visual/radar satellite detection shielding technology (which causes the problem)."
- Two Bremerton readers reported that something has been interfering periodically with the radio signal that controls their household atomic clocks. The clocks display the exact time, as broadcast continually over several radio frequencies between 2.5 and 20 MHz from a transmitter in Colorado that is linked to the U.S. Naval Observatory's atomic clock. One clock owner said the problem has persisted intermittently even after the keyless remotes began working again Monday.

  Other readers reported problems with TV reception, car alarms and computer microchips in Bremerton and Port Orchard last week during the period of disruption.

- Employees of state and local government agencies reported that their radio systems experience periodic failures in the Bremerton and Bangor areas. "We've called (PSNS), and they won't tell us one way or the other," one respondent wrote via e-mail. "If we knew when they were testing it would help."
- A respondent who identified himself as a "Russian geophysicist" sent an e-mail from Moscow suggesting other possible sources of the disruption, such as rogue TV signals or police communications gear.

(Article by Lloyd A. Pritchett, The SUN newspaper of Bremerton, Wash. USA, March 2001, http://www.thesunlink.com/news/2001/march/03302mystery.html, sent in by Graham Eckersall, G4HFG, who saw it referred to in the ARRL news (US ham radio organisation) in April 01.)

126) Mobile phones can trigger remote-controlled explosives

In the corner of the town square, four GIs huddle behind a wall. Someone yells: “Incoming!” A huge explosion lifts the ground, raining down heavy clods or earth that hurt if you don’t turn your back. “Glad I moved you up?” smirks the director, Tony To, having advised a more sheltered vantage point than that previously adopted. The crew set up for the next shot. A warning: mobile phones off. Incoming calls can trigger remote-controlled explosives.

(*Extracted from an article by Jeff Dawson, in the Sunday Times TV and Radio Guide, 13th May 01, page 4. Jeff was watching a programme about the second world war being made.*)

127) Two lightning incidents

After a lightning strike to a factory, a servo-operated packaging machine was found to be operating backwards. It continued to operate at full speed even when its guards were opened, despite supposedly having a hard-wired safety system.

(*Contributor wishes to remain anonymous, May 01.*)

Late last year, lightning struck in the car park area of a UK Building Society’s town centre headquarters. Large voltage surges knocked out the security cameras, and were transmitted to other electronic equipment in three buildings via the connecting cables. Once they had entered the building’s electrical systems, the voltage surges damaged the security system, fire alarm and distributed computer equipment.

Latent damage was also caused to the interface between the fire alarm and the radio tag-operated automatic door system, but this went unnoticed at the time. The problem was identified only when a fire alarm went off some weeks later and staff were unable to exit through the automatic doors. Fortunately it was a false alarm.

*(Taken from “*Don’t lose your data in a flas*h” by Tony Harrison, Electrical Review, Vol. 227 No 12, 10-30 June 94, page 90, www.electricalreview.co.uk)*

128) The indications are that lightning strikes are on the rise in Europe.

And it can be expected that damage from these strikes will also be on the rise.

*(Taken from “*Markets for Power Line Surge Suppressors in Europe*” by Christopher Lanfear, PCIM Europe, Nov 2000, Page 34.)*

129) Seven EMI incidents reported by Dag Björklöf

Today we can easily find examples of more or less serious electromagnetic problems:

- The magnetic field caused by ground currents in the water pipe system makes it impossible to use sensitive electronic instruments in part of a hospital building.
- A patient-coupled infusion pump is damaged by electro-static discharge, but thankfully the alarm system is not affected, and a nurse is alerted.
- An operation using a plastic welding machine cause interference with a patient monitoring and control system; the monitor fails to detect that circulation has stopped in the patient’s arm, which later has to be amputated.
- A wheelchair carrying a handicapped man goes out of control when it comes close to a radio station antenna mast, and eventually the occupant is ejected into the street.
- A robot starts running amok due to a radio control transmitter, smashing all equipment within its reach. *(Editor’s note: always make sure the mains isolation switch for a robot is outside its possible reach!)*

- Interference from a passing truck with a radio transmitter causes a crane to drop its load on a person.
- A passenger's laptop causes a plane's navigation system to malfunction, causing the aircraft to go off course.

*(Taken from "*Immunity testing: Examining requirements and test methods*" by Dag Björklöf, Compliance Engineering European Edition's 1999 Annual Reference Guide, page 51, www.ce-mag.com.)*

130) Illegal CB transmitters on trucks

Radiocommunication Agency (RA) officials obtained convictions against truck drivers for using illegal citizens band (CB) radios. The convictions came as a result of an official stake out of two truck stops on the M4 highway in Wiltshire, U.K., last October.

(*Taken from: "*Enforcement Efforts Around the World*" Conformity 2001, page 209, www.conformity.com.*) (*Editor's note: Almost certainly these truckers were using illegal high-power boosters, capable of creating very high field strengths over large distances. Not a good idea when incidents such as described in the 6th bullet of No. 129 above can occur.*)

131) Bluetooth and Wi-Fi can interfere with each other

The co-existence of Bluetooth and Wi-Fi in the 2.4GHz Industrial Scientific and Medical (ISM) band was discussed at the recent Wireless Symposium in San Jose. Because the simultaneous operation of these two systems can interfere with each other, the search is on for ways to improve their performance when they are in proximity.

As explained by Jim Lansford of Mobilian Corp. (Hillsboro, OR), these two technologies (known as WPAN and WLAN) are headed for significant growth. "Co-existence has become a significant topic of analysis and discussion throughout the industry", says Lansford. "With both of them expecting rapid growth, co-location of Bluetooth and Wi-Fi devices will become increasingly likely." "They create in-band coloured noise for one another. Neither was designed with specific mechanisms to combat the interference from the other. Bluetooth assumes it will hop away from bad channels. WLAN (802.11b) assumes that if it fails, two Wi-Fi stations tried to transmit at the same time."

(*Extracted from "*Living in a Wireless World*" by Sherrie Steward, Compliance Engineering, March/April 2001, page 10, www.ce-mag.com.*)

132) Interference in the 2.4GHz band

Any time you have more sources of RF energy, the EMC design must accommodate with greater immunity. One area of growth is the use of the 2.45GHz band, where such activity as Bluetooth, cordless phones, HomeRF, new RF lighting, and other systems are all vying for use and must work with each other's ambients. There have been claims of interference, but this situation is still coming to a boil. It is only a matter of time before products with lesser immunity in this band will not work together at all user locations.

(*Taken from "*EMC in a High-Frequency World*" by Donald N. Heirman, Compliance Engineering, Jan/Feb 2001, page 30, www.ce-mag.com..*)

133) 15 percent of all computer server crashes can be attributed to electromagnetic interference.

*(Taken from "*The EMC Building: design and construction strategies*" by Jose M Rio, ITEM Update 2000, page 28, www.interferencetechnology.com.)*

134) Problems with GPS reception caused by interference

It can clearly be seen from table 1 that GPS receivers are very sensitive compared to the others (GSM and Bluetooth) and not surprisingly, this means they are more prone to interference. For military applications this problem is largely solved by the use of controlled reception pattern antennas which electronically 'point' the antenna at the satellite, boosting the signal to interference ration by typically 30dB.

GPS signals can be interfered with by harmonic interference from commercial TV stations and mobile telephone base-stations. In some countries, including Germany, Austria and Hungary the GPS frequency band is also shared by local fixed radio services and GPS reception is impossible in some (small) areas of Hungary for this reason.

(*Taken from "*GSM, GPS and Bluetooth in an Automotive Environment*" by Dr Peter Miller, Euro-EMC's EMC seminars 3-5 April 2001.*)

135) Catastrophic emissions from cable TV in German aeronautical security bands

In spite of using coaxial cables in cable TV distribution systems there is a lot of shield leakage, based on technical imperfections and ageing. Catastrophic emissions in the aeronautical security bands are jamming Germany. LANs and WANs are growing increasingly, adding to this critical situation.

(*Taken from "*Megabits Per Second on 50Hz Power Lines*" by Diethard Hansen, IEEE EMC Society Newsletter, January 01, www.ewh.ieee.org/soc/emcs/.*)

136) Interference possibilities between AM radio broadcasting and telcom xDSL

According to her study (Kate Harris, International Switching Symposium 2000, Birmingham, UK) measured ADSL data rates suffer as much as a 2000-b/sec drop when exposed to RFI, which can occur in the bands where DSL networks and AM broadcast share the same spectrum. In North America, this sharing occurs at the medium-wave AM broadcast band. The downstream bands of ADSL and ADSL.lite intersect with AM radio broadcasts in the 535-1104 khz and 535 – 552 kHz ranges, respectively. There is no overlap between their upstream bands and AM radio broadcast. In fact, the narrow overlap of ADSL.lite and AM radio enables minimum capacity loss in ADSL.lite services when combined with low-pass filtering and modern RFI immunity.

In Europe, however, the upstream band of symmetric high-bit-rate DSL (SHDSL) does share spectrum with AM radio, at the long-wave AM band. And the downstream bands of ADSL and ADSL.lite overlap the long-wave AM band in addition to the medium-wave AM band. Therefore, DSL networks in Europe must contend with a broader RFI threat.

According to Eckert, regulatory agencies are more concerned about egress (interference with AM radio caused by the DSL systems) rather than ingress (interference experienced by the DSL system from AM radio transmissions). But because DSL services are 'white' and not concentrated in a carrier, interference produced by these services sounds like white noise, making it difficult for AM radio users to identify the problems as interference. Complaints received by a regulatory body would not necessarily pin-point the origin of the interference or the use of a DSL product as the culprit. So regulatory bodies have been slow to act, which has in turn slowed standards work.

(*Taken from "*Addressing the Risk of RFI to and from DSL Networks*" in Compliance Engineering Jan/Feb 2001, pages 12 and 14, www.ce-mag.com.*)

137) Electronic article surveillance (EAS) can interfere with implanted medical devices

Additional areas being investigated by the FDA include electronic article surveillance (EAS) machines and their impact on implantable medical devices. The EAS machines are utilised as anti-theft devices in the exits of many retail stores. There have been instances caused by the interaction of these electromagnetic machines and implanted medical products.

(*Taken from "*Update on Medical Devices and EMC*" by Daniel D Hoolihan, ITEM 2000, page 84, www.interferencetechnology.com.*)

138) Unusual types of ESD

Two unusual forms of ESD, internal chair discharges and metal-to-metal discharges from "jingling change" have cause severe field problems in electronic equipment. These forms of ESD are not covered by any current standard.

- When a person rises from a chair, charges are generated on both the surface of the chair seat and internally that can cause ESD events to occur inside of the chair. These discharges are between metal parts of the chair that are not electrically connected to each other. The discharges cause intense electromagnetic fields to be radiated from the metal parts of the chair, usually the legs. This radiation has been shown to be capable of disrupting the operation of nearby electronic equipment.

  This effect was first reported in 1993 by Honda and Smith. Most chairs I have observed with this effect produce about a dozen discharges over the first 10 to 15 seconds after a person rises from the chair. However, some office chairs are capable of producing several hundreds of discharges over as much as a minute. Just purchasing "ESD safe" chairs alone will not eliminate the problem.

  I have personally observed an "ESD safe" chair in a factory emitting this type of interference. Since 1993, many types of equipment have been affected by this phenomenon, including communications equipment, computer equipment, even critical equipment in the field of aviation.

- When small pieces of metal, such a pocket change, move around inside of an insulating pouch such a pocket or plastic bag, they generate different charges. When they touch, small ESD events are generated, for the most part too small to be seen. I have measured risetimes of the fields to be smaller than 100 picoseconds, with sub-nanosecond pulse widths.

With the increasing speed of electronic circuits, many types of circuits have become susceptible to this form of interference. I have caused upset by shaking a plastic sandwich bag with a handful of pocket change near communications equipment, a 100MHz PC, and some consumer electronics. In one case, shaking a bag of coins 3 feet from a rack of equipment caused dozens of red LEDs to light!

*(Taken from "*Unusual Forms of ESD and Their Effects*" by Doug Smith, Conformity 2001, page 203. The article originally appeared in the 1999 EOS/ESD Symposium Handbook, and can be downloaded from http://www.emcesd.com.)*

139) Intercepting and reconstructing VDU monitor signals at 1km or more

You might be interested to note that it is possible to intercept VDU emanations at 1km for monochrome and more for RGB. Both figures are likely to be greater using sophisticated technical means.

(*Taken from a discussion about TV detector vans and TEMPEST in The Register, www.theregister.co.uk, 4th March 2001 by Andrew Orlowksi, sent in by Graham Eckersall.*)

140) Computers and earthing/grounding impedances at high frequencies

In a newly-constructed financial dealing room, the earthing was done as per IEE Protective Earthing (BS7671). After 2 weeks the US made computer equipment failed. US engineers said it was due to leakage currents from their ITE. Protective bonding for safety is only concerned with 50Hz currents, and is not adequate for modern computers which need a lower earth impedance at higher frequencies because of earth leakage from their mains filters.

In a large computer installation earth leakages (alone) of 70A have been measured at the main earthing terminal, and they are rarely less than 10A.

(*From Peter Smith's presentation of his paper "*Protective or Clean Earthing – a Potential Difference*" at ERA's Earthing 2000 Conference 2000, Solihull, 21/22 June 2000, www.era.co.uk.*)

141) Experiences with filtering RS232

We have a product used in-vehicle for vehicle handling testing (see the SR30 robot stuff on our website if you're interested). One version has a control box that incorporates the closed-loop position controller, servo-amp, interlocks etc and communicates with a remote lap-top, usually part of the end-users data capture system to select the test type and set-up and to upload any test information captured in the controller card.

Early experience suggested that separating the ground references of the remote equipment (normally cigarette-lighter powered) and our control system (direct battery powered; it takes up to 100A instantaneously but has a tare drain of 5A) were a good idea, to prevent the inevitable fighting over the apparent vehicle chassis '0V' reference. We therefore installed the proprietary opto-isolated serial comm's card supplied by the controller manufacturer and used a shielded comm's lead (RS232) with the shield connected at one end only – our end in fact.

Six of these units had performed quite happily in the field (and flew through the fairly arduous 30V/m tests used in automotive EMC testing) but the seventh seemed to be very sensitive to the particular laptop/power unit combination used. Very regularly the serial comm's would lock up when the PWM servo amp was enabled.

With the unit back at our base the symptoms were all too readily reproduced on the end user's laptop (but not with the newish Dell used in all our testing). Looking at the serial comm's lead I noticed something different about the 9-pin D-type connector at our end; it had been fitted with a flexible push-in capacitive filter 'thingy', of the type available from RS and used on some of our equipment.

As this was not (and had not been) part of the standard assembly I removed it, and the serial comm's problem was instantly solved!

I can only imagine that this 'thingy' was not acting as a filter but was acting as a convenient means for noise to be injected onto the cores of the serial comm's lead. The connections entering our control case are on the isolated side of the opto card, referenced to the 0V potential of the remote laptop. The connector shell is referenced to our case and its control 0V potential, therefore if our case potential moves relative to the RS232 cores (as I can only imagine it must be when the amplifier is enabled) the capacitors in the filter will act as convenient low impedances directly injecting noise onto the cores.

Fitting the filter 'thingy' at the laptop end is, of course, the thing to do ...... and moving the shield connection to that end should also help, otherwise the transfer capacitance twixt shield and cores could also be a problem in much the same way as the capacitive filter!

(From Dave Bethell, Anthony Best Dynamics Ltd, www.abd.uk.com, 25th June 01)

142) Intermodulation of two broadcast transmitters interferes with automatic garage doors

We have news from down-under about things that bump and grind in the night... Australia's ABC TV and Sydney's new FM radio station 'Nova 96.9' have unwittingly joined forces to meddle with automatic garage doors. VK2WI reports that hundreds of radio-controlled garage doors across Sydney have been overloaded by the ABC and Nova transmissions and some are refusing to open and close. In several cases the doors have developed a life of their own, randomly opening and closing at all hours. The reason is that Nova broadcasts on 96.9MHz and the ABC TV sound signal is on 69.75MHz.

When the two signals mix in an overloaded door receiver, the result is a 27.15MHz signal, which passes straight through most door receivers which are tuned to 27.145MHz, only 5kHz different. This causes erratic behaviour, dependent upon signal content, and the doors open and close in sympathy. Perhaps the designer has sleepless nights, too!

(F*rom Graham Eckersall G4HFG / W4HFG 6th July 01, who got it from the 'News' section of the RSGB website, www.rsgb.org.*)

143) Radio transmitters interfere with photographic cameras

Subject: Bizarre Solution... What you describe is a common problem to commercial-radio technical folk. Proximity to active radio-transmitting antennas can cause really wild things to happen to electronic circuits such as the metering portions of your 645 Pro. (It's interesting to note that even some very well-designed and expensive electronic test equipment can be rendered essentially useless by these strong radio-frequency fields.)

The wiring within your camera (it may be nothing more than a centimetre or so of printed-circuit land on a fiberglass circuit board) acts as an antenna. The signal it picks up can then be rectified (changed from a radio signal to a small D.C. voltage) and this voltage can, in turn, add to or subtract from the small voltage generated or controlled by the light-sensing elements in your camera metering system. I would guess that if it adds, you get underexposure; if it subtracts, you get overexposure. It will depend upon exactly how the rectification occurs in the camera circuit.

A parallel case of this type of interference occurs when an automobile with a radio-controlled door lock is located near a high-powered radio or television transmitting tower. Often, it's impossible to unlock the car using the small, keychain-type device because of the same type of effect. In some cases, a particular program signal will trigger the car alarm! The tops of some of those California hills are loaded with radio transmitters and can contain very strong radio-frequency (RF) fields. It would be my guess that the metal housings of some cameras would shield the internal electronics from RF effects.

Of course, a plastic housing offers little such shielding. At best, even a metal-bodied camera would be subject to "radio interference." It can be pretty squirrely stuff! Radio signals and light are both forms of electromagnetic radiation and the inverse square law works for both. The best cure, therefore, is increasing the distance between your camera and the transmitters. As a radio engineer, I've learned long ago that you just can't do certain things close in. Hope this simple explanation helps.

(*David Mehall, 22 Aug 1996, from an email thread on photography.*)

144) Video surveillance system interferes with car central locking and security

Gun Wharf, a leisure centre in Portsmouth, opened in Easter 2001. It had an underground car park, and the car park had a video surveillance system. It seems that electromagnetic emissions from the video system would often interfere with car central-locking and security systems – locking the cars as soon as they were unlocked, or just not allowing them to be unlocked at all. Many people had to leave their cars in the car park and take taxis home.

(*From Anne Cameron, Alenia Marconi Systems, 6th July 01*)

145) Electromagnetic weapons could be used for Information Warfare

A relatively recent (1997) definition of Information Warfare given by the Ministry of Defence is: "The deliberate and systematic attack on critical information activities to exploit information, deny services to the authorised user, modify and corrupt data." The issues involved reach well beyond the realm of military warfare, extending to e-business, e-commerce, e-finance and e-government. The power, water and food distribution systems, the emergency services, air traffic control systems, the banking sector and the financial markets, to name but a few, are all dependant on networked digital systems for effective communication and control.

It is a sobering reflection that 'the most advances society in the world is really only four meals away from anarchy, and if you could attack a society through its computers to cause the breakdown of the mechanisms, the infrastructure, which cause it to run, you will bring about mass deaths.'[4]

Line of sight devices. Two distinct classes of line-of-sight devices have been described. The first is a form of low-energy radio-frequency (LERF) jammer, which can be used to temporarily disrupt digital electronic circuits at close range (of the order of metres). Since any cable or circuit component in an electronic system is in principle an unintended antenna, capable of both transmitting and receiving at its characteristic frequency, a low-energy wide spectrum RF field will contain with high probability frequencies matching the resonant frequencies of critical circuit components.

If this is the case then the system would go into 'random output mode'; its behaviour would be impossible to predict, but could range from single recoverable processing error to total loss of the RAM contents.[15] A parts list and circuit design for such a low-tech device was posted on an Internet bulletin board in 1995 and described at InfoWarCon in 1996. The device was subsequently built and tested in the UK to check the veracity of its design.[10]

The second class of device is the high-energy radio-frequency (HERF) gun or non-nuclear electromagnetic pulse (NN-EMP) cannon, which can permanently damage digital circuits at longer ranges (or the order of a kilometre) by blasting them with a pulse of microwave energy in the Gigahertz frequency range. The MOS chips are effectively 'fried' by this process. HERF technology is high-tech and remains the subject of classified military research.

However, the unclassified technology had been reviewed and discussed in detail.[16] In order to protect (or 'harden') systems against RF attack they need to be entirely enclosed in a Faraday cage, ideally including the electrical power feeds and communications links, since these can act as antennas for the RF field or EM transients.

Eavesdropping and surveillance. Since a cable or circuit component can act as a transmitting antenna, unshielded computers and networks are liable to leak compromising RF emanations that are a potential source of intelligence. Passive intelligence gathering from unshielded systems (ElInt) has been given the name TEMPEST (transient electromagnetic pulse emanation standard, see Reference 16, note 3) while emanations specifically arising from the CRT screens of VDUs are known as van Eck radiation after the scientist who was able to demonstrate remote reconstruction of the screen contents using low-tech equipment.[17]

It has been pointed out that malicious software could be used to infiltrate a target system, obtain critical information, and encode it in the system's Tempest emanations in order to broadcast it back to the attacker.[18]

Summary and prospects. The threats to, vulnerabilities of, and impacts on critical national infrastructures (CNI) are real and capable of assessment, although in practice this is a complex and challenging task, the more so since information warfare possesses several characteristics of that are not shared by conventional warfare: it is global (there are no borders); it is precise (surgical strikes are possible); it is un-proportionate (the cost of attack is much less than the cost of defence).[19]

Some of the accounts of information warfare carried by the media have been exaggerated or are inaccurate, but this must not deflect us from addressing the crucial issues of defining, developing, and deploying critical infrastructure protection (CIP) policies and strategies.

(*Extracted from "*Information Warfare: battles in cyberspace*", by Richard E Overill, IEE Computing and Control Engineering Journal, June 2001, pp125 – 128, www.theiet.org. There was a lot about hackers and such, which has been omitted from this extract.*)

146) Case #22804: Lead boxes – Good for Kryptonite, bad for CRT monitors.

A prestigious New York Hotel had upgraded their check-in and reservation computers to modern PCs with colour CRT monitors. One unit's screen, in the managers office, was nearly impossible to read due to a wavy image. Magnetic fields at up to 60 milligauss were found at the monitor location and were coming from a power company electrical vault under the sidewalk outside. Some monitors can be disturbed by as little as 10 milligauss.

Due to some bad advice, the hotel had an aluminium box built (didn't work), then a lead box (didn't work either but at least now the monitor was protected from Superman's X-ray vision). Eventually they came to us and our standard five-sided 'ImageGuard' CRT monitor enclosure did the trick.

(From the Journal of Magnetic Shield Case Studies, an in-house advertising medium published by the Magnetic Shield Corporation, www.magnetic-shield.com.)

147) Financial risks and EMC compliance

Silicon Film Technologies, the firm developing a digital 'film' that fits in a standard SLR camera body, has suspended operations because of failure to meet EMC standards. "The failure of certification tests in the summer delayed Silicon Film's anticipated revenues, but development expenses continued," said Robert Richards, president and CEO of Irvine Sensors, the firm's largest creditor.

Last week Silicon Film said it had met the FCC emissions requirements but could not conform to the stricter European standards. "We believe at least some of those stricter standards must be met for a successful product launch," added Richards. If alternative finance is not found, the firm – 51 per cent owned by Irvine Sensors – will go onto liquidation.

(From Electronics Weekly, 19th September 2001, www.electronicsweekly.com.)

148) A make of residual current detector (RCD) tripped out by walkie talkies

A particular make of 30mA RCD units fitted in plastic consumer units in site contractor's portable cabins would trip when the walkie-talkies used by the contractors were keyed within 1 metre distance. Replacing them with a different make of RCD solved the problem.

(From Chris Byrne of CB Electrical Engineers Ltd.)

149) Numerous stories of external RF sources interfering with aircraft

The penetration of high-intensity radiated fields (HIRF) into conducting enclosures via apertures is an EMI issue that is relevant to all aviation. The stories are numerous, of disrupted communications, disabled navigation equipment, etc., due to the effects of sources external to the aircraft.

*(Extracted from "*HIRF penetration through apertures: FDTD versus measurements*" by Stavros V Georgakopoulos, Craig R Bircher and Constantine A Balanis, IEEE Transactions on EMC, Vol. 43 No. 3 August 2001 page 282.)*

150) EMI and the selection of heat-sink thermal gaskets

It should be emphasised that changing heat-sink gasket material as an EMI mitigation strategy is limited to cases in which the heat-sink patch resonance constitutes a significant part of the overall coupling mechanism. Even then, it is necessary to ensure that the shifted patch-resonance does not coincide with a clock harmonic.

Despite these limitations, there are at least two commercial products in which the substitution of one electrically insulating heat sink gasket for another (of the same size but different composition) has resulted in significantly reduced EMI at certain troublesome frequencies. In one of these cases, this reduction was sufficient to allow the product to meet FCC requirements.

*(Extracted from "*EMI considerations in selecting heat-sink thermal gasket materials*", Huang et al., IEEE Transactions on EMC, Vol. 43 No. 3 August 2001 page 259.)*

151) EMI issues loom for future development of single-electron semiconductors

Each year the size of transistors shrinks, thereby improving performance (*but not EMC performance! – Editor*). Yet, according to Technology Review, transistors must be big enough for electrons to pass through. Preparing for an inevitable impasse, Toshiba has demonstrated a transistor that can turn on and off based on the movement of a single electron. Unlike other quantum-level transistors, the device operates at room temperature. It's also the first successful hybrid circuit, mixing single-electron transistors with traditional metal-oxide transistors, which are required to boost the weak quantum-level signal.

Chips based on the circuit should offer blazing performance and low power consumption. Before building a full-fledged processor, researchers face challenges such as finding a way to protect the chips from the disrupting effects of stray electromagnetic fields, electrical discharges, and physical movement. Hybrid chips should be available for use by 2010.

(From Electromagnetic News Report, July/August 2001, Pages 11-12, www.7ms.com.)

152) 50 years ago: ignition systems to be suppressed

The Postmaster General's Advisory Committee on Wireless Interference from Ignition Systems has now presented its report. The Committee devoted its attention in the main to the abatement of interference with the television services of the BBC from ignition systems, including those used in motor vehicles, motor boats, fixed or portable stationary engines, motor mowers, tractors, etc. The Committee's recommendations are based on the assumption that all reasonable measures will be taken to reduce the susceptibility to interference of receiving installations.

They recommend that ignition equipment, when installed as intended, should not radiated an interference-producing field which exceeds 50 microvolts per metre in the 40-70 megacycles per second frequency band, measured on specified equipment at a point not less than ten metres distant. The committee advise that suppression to this amount can be achieved with negligible effect on the mechanical performance of the engine. In the case of about 60 per cent of existing motor cars the Committee think that the required degree of suppression can be achieved by fitting a single resistor costing about 2s 6d.

(From: Council Notices, The Journal of the IEE, September 1951, www.theiet.org.) (Editor's note: 2s 6d is equivalent to 12.5p now, or about 18 cents US. Of course in 1951 this amount of money was worth a lot more than it is now.)

Items 153-159 below are provided by Keith Armstrong of Cherry Clough Consultants, and come from various speakers at the "War Stories" forum held on the 17th August 2001 at the IEEE's 2001 International EMC Symposium held in Montreal, Canada.

153) Magnetic fields from set-top box interfere with TV

An early set-top box was found to interfere with the picture of the TV it was placed on top of, but only after 2 to 5 minutes. The designers had spent months making sure that the emissions from the product were very low. Then they found that the product caused the same interference when no cables were plugged into it, and then even when it was switched off!

It turned out to be due to the magnetic fields from the stereo speakers in the TV. Placing any metal object on top of the TV caused similar interference problems, after a few minutes.

154) Furniture ESD crashes computers

A particular computer manufacturer had a software lab that checked the compatibility of their new products with a number of applications. With one new product the evaluation systems shut down when the testing staff left the room. The new product at that time consisted of a motherboard and HDD with no enclosure, plus the usual keyboard, monitor and mouse.

It turned out to be caused by the induction field developed by the static charge between the staff and their furniture when they stood up (not a spark, just a changing 'static' field). This field interfered with sensitive circuits on the exposed motherboard and caused the shutdown.

155) EMC test results varied with cloud cover

Testing the shielding effectiveness (SE) of an aircraft on an OATS (Open Area Test Site). The engineers had shielded a wheel well using aluminium foil and a ground strap and were confused by random variations in the SE of up to 20dB. These variations were eventually noticed to correlate with the clouds passing in the sky, but at night there were no variations in the measured SE.

The problem was eventually found to be caused by corrosion between the grounding surfaces. Heating and cooling of the aircraft's metalwork due to the sunlight and shade caused by the clouds caused the quality of the electrical bond at the corroded grounding surfaces to vary, causing corresponding variations in the SE of the wheel well. It proved possible to simulate the problem by banging the aircraft with a length of 2x4.

156) Amplifier IC's lead-frame and bond wires very susceptible around 950MHz

A new non-invasive blood pressure monitor was an electronic version of the old 'cuff' method. While testing it for RF immunity it would fail to measure at all between 950 and 1000MHz. It was found that its pressure sensor was outputting misleading signals during the test, despite being a standard part that had been used for many years without problems (or so claimed its salesperson). The pressure sensor had a 6-pin package, with 2 unused pins marked "do not connect". Copper tape over the transducer and its pins made the problem go away. The problem was then isolated to just three of its pins, one of which was a compensation capacitor for the sensor's internal amplifier. An engineer working for the Japanese company that made the sensor said that he had seen the problem before in an automotive application.

The N/C pins were connected to the inputs of the internal amplifier and used for performance checks during production testing. The pins were acting as antennas, picking-up the external RF field and injecting it into the internal amplifier at its most sensitive point, where it would be inevitably rectified (demodulated) by the semiconductor junctions in the amplifier's IC and cause major shifts in DC operating points. Even with these pins cut off from the package the problem still remained – the amplifier was so sensitive that the internal leads and the bond wires to the IC still made effective antenna at 950MHz.

Eventually the sensor was modified by the manufacturer so that it did not have this problem. In the meantime one year's worth of production of the new product suffered the additional cost of $20 per unit for a shielding can and its fitting.

157) Tape recorder interferes with aircraft control system

We put a tape recorder into a drone aircraft used for surveillance. When the tape recorder came on, the drone nose-dived. The 10kHz bias oscillator for the tape recorder was exactly the same frequency as was used by the aircraft's control system, and this caused the problem. The moral of this story is to avoid using standard frequencies.

158) How many EMC engineers does it take to change a light bulb? No. 1.

A 20 Amp 20 Volt power supply for a medical xenon lamp had to meet EU emissions standards. The PSU was to be fitted in various boxes, some of which could be plastic, so needed not to have to rely on any shielding from its enclosure. The output of the PSU had a 50 microHenry choke in series, to generate the high voltage which would 'kick-start' the discharge in the xenon lamp. Unfortunately, 20mA of RF common-mode current was measured the lamp cable!

After a lot of work on the power supply, to no avail, someone tried a different type of lamp and found that the RF noise was 40dB less. Three other types of lamp were also found to be 40dB less noisy. Then other xenon lamps of the same type as the original noisy one were tried and found to be 40dB quieter too. So it seems that all xenon lamps are not created equal.

By the way, the answer was: four engineers.

159) How many EMC engineers does it take to change a light bulb? No. 2.

We had designed a shoe repair kit for use by the US army. The only electrical item in it was a standard domestic-type incandescent filament lamp that ran from 110V 60Hz, so the squaddies could repair their shoes at night. Unfortunately, our regular contact with the military was on an assignment elsewhere and we had to deal with a novice who didn't understand EMC at all and insisted that we had to fully test the shoe repair kit to MIL-STD-461, the US military's EMC standard.

He would not be moved by our arguments that the testing was a waste of time. He was following the procedure and it was more than his job's worth to believe us when we said that it didn't need testing as it was bound to pass. So we had to do the tests.

Imagine our surprise when our shoe repair kit failed its emissions test by a significant amount at 45MHz! We soon discovered, of course, that this was due to the light bulb. When we contacted Sylvania, its manufacturers, we eventually discovered that around 1% of all incandescent light bulbs (not just Sylvania types) had VHF oscillations, typically occurring between 28 and 45MHz and caused by a 'monode' gas plasma oscillator occurring in the very hot gas close to the coiled filament.

The emission frequency could not be predicted because there was no configuration control during manufacture for the aspect of the filament construction that caused the VHF oscillation. As far as we know, this 1% problem with incandescent filament light bulbs is still around.

We don't remember what the answer was in number of engineers, but it was quite a few.

Items 160 - 169 have been very sent in by David Blake BSc CEng MIEE, Managing Director of Electronic Design Solutions Ltd – a compendium of interference problems and their solutions over 30 years.

160) **Interference with TV sound from unused set-top box**

This is a supplement to Banana Skin no 153 in Issue 37. The stereo speakers on our television had been making rude reverberating noises for some time, particularly so when the sound was moderately loud in the bass. On reading in Banana Skin 153 about the metal chassis of an early set-top box causing picture interference, I removed the old set-top box, which we never use, from our T.V. and the sound is now OK. So it seems that interference from a metal plate above the television set can affect the sound as well as the picture.

161) **Noise from alternator in motor-generator set causes computer malfunctions**

In the mid 1960s, a London bank was experiencing malfunctions in its new mainframe computer. On the assumption that the cause was mains-borne interference from extraneous sources, a motor alternator set had been installed at the bank to isolate the computer from the mains. That done, the malfunctions continued. So they asked Eric Langham for help.

He found radio frequency ringing on the mains input to the computer, triggered by abrupt changes in alternator volt drop apparently brought about by sudden changes in load current during operation. The addition of R-C snubbers across the three phase input to the computer eliminated the RF ringing and cured the problem. *(Told to David by Eric Langham, Chartered Electrical Engineer.)*

162) **Mains power noise causes 250hp fan to vary speed**

Small amplitude hunting of the speed of the DC thyristor drive of a 250 hp extraction fan was largely unaffected by experimenting with the values of the R-C stabilising circuit around its speed error amplifier. Then, quite suddenly, the hunting stopped - coincidentally, it transpired, with the chief electrician switching on the automatic power factor correction system in the electrical sub station as the factory load increased.

With hindsight, it is apparent now that cyclic voltage dips in the electric mains originating from commutation in other phase angle controlled thyristor power equipment had been delaying the latching of the thyristors in the fan drive (which were fired by trains of short pulses) until the introduction of the power factor correction capacitors reduced the amplitude of the dips. *(From when David was Senior Systems Engineer for E M Langham, Chartered Electrical Engineer, 1962-79.)*

163) **Inadequate contact suppression caused interference with guillotine control**

Various guillotines cutting material to length were frequently making double strokes. The source of the trouble was found to be RFI generated when the output contact of the length counter switched the initiating relay in the guillotine control. The contact had originally been suppressed by an R-C snubber comprising 100 ohms in series with 0.1 microfarads connected across it inside the counter. In some counters these components had blown up and were open circuit!

Bench testing of the several types of relay used in the guillotines showed that the original capacitor was too small, in some cases, to limit the peak voltage transient to within its own voltage rating. The shortcoming was cured by connecting appropriate R-C snubbers in parallel with the coils of the guillotine relays. *(Yet another from when David was with E M Langham, Chartered Electrical Engineer.)*

164) **Missing low-cost capacitor causes costly machine shutdowns**

In the early 1980s, an electronically controlled flying saw occasionally (perhaps once or twice during an eight hour run) switched itself off whilst cutting slowly moving heavy density material into short lengths. Each event cost some £1000 in lost output whilst the scrap material was cleared and production restored. At the end of an all-night vigil, the user's systems control manager traced the cause to be the false triggering of an integrated circuit monostable in the 24 volt DC control sequencing logic, coincident with a brief period of heavy regeneration of the thyristor controlled main DC drive during its operating cycle.

Bursts of thyristor commutation current generated disturbances which caused radio frequency ringing at the output of an autotransformer which had been installed to match the 430 volt factory supply to the 380 volt rated German electrics.

RFI was breaking through into the 24 volt DC supply because a small capacitor, shown on the circuit diagram, had been omitted by the manufacturer. Critically damping the autotransformer output leakage inductance by R-C snubbers and installing the missing capacitor effected a complete cure. *(From when David was Systems Control Manager at the Cape Insulation Rocksil Works in Stirling, 1979 to 1987.)*

165) Furnace heat control interferes with oxygen sensor

Variations in the analogue output signal of a flue gas oxygen monitor operating from a probe in the waste gas duct of a glassmaker's furnace were traced to common mode interference from the furnace heating phase angle controlled electric boost. The coupling was found to be directly conductive and its effect dependent upon probe temperature.

Operation adequate for using the probe signal to control the combustion air/oil ratio was achieved by re-siting the probe further away from the furnace and its boost electrodes in a less hot part of the flue. *(Another from when David was at the Cape Insulation Rocksil Works.)*

166) Defective contactor interfered with thyristor heating controller

The cause of sporadic false firing of its thyristors which, when it occurred, switched the output of a single phase heating controller to full power was under investigation. Then the problem suddenly ceased when the firm's electrical engineer, acting quite independently, discovered and disabled a defective electrical contactor in the mains power factor control system. *(Another from when David was at the Cape Insulation Rocksil Works.)*

167) Incorrect installation of screened cables causes problems with machine

The output thyristors in photocell detectors in the rolling unit of a multi-section pipe making machine were failing to latch on immediately and delaying the response of the control system. Cure was effected by re-routing their screened cables directly back to the control cubicle through dedicated individual steel conduits. Then the same defect was found elsewhere on the machine. Detailed investigation revealed that the manufacturer's technician had installed and earthed all the screened cabling in a manner contravening his firm's explicit documented instructions.

So, during a fortnight's shutdown brought about by the need to carry out other remedial work, the user's electricians revamped the screened cable terminations and cured all the associated malfunctions. *(Yet another from when David was at the Cape Insulation Rocksil Works.)*

168) Switch interferes with crane control system

The inverter powering the hoist drive of an overhead travelling crane frequently tripped during long travel, coincidentally with the operation of a limit switch which directly switched a tungsten filament indicator bulb in the driver's cabin. RFI from the switch was found to be injecting a false motor speed feedback pulse train into the control system and transiently grossly mismatching the inverter voltage and frequency output to the needs of the motor.

The malfunction was cured by removing the lamp bulb as the crane driver did not need the indication. *(From when David was Managing Director of Pace (Stirling) Ltd - consulting engineers – from 1987 to 1998.)*

169) Walkie talkie interferes with crane hoist’s load cell

When checking the calibration of load cell equipment in the hoist mechanism of an overhead travelling crane, it was found that its electronic signal converter could be made to give any value of analogue output voltage between zero and full scale (10 volts) dependent upon the proximity and orientation of the tester's walkie-talkie radio. No remedial investigation was undertaken because no personnel would be on the crane during normal operations and maintenance staff now knew not to use a walkie-talkie there.

Possible effects from other sources of RFI, such as inverter drives, were not looked for because the equipment performed reasonably enough in normal circumstances. *(Another from when David was Managing Director of Pace (Stirling) Ltd.)*

170) Some thoughts on EMC and safety, and the security of bank accounts

Personally, I could list a ton of stuff that would instil fear and loathing amongst the faintest of EMC hearts. Sitting in a jet airliner at the end of the runway readying for take-off and watching the cabin lights dim slightly in sync with the sweep of the main radar dish just a couple of hundred yards away. ESD events in the kitchen area of the airliner causing the phone in the cockpit at the other end of the plane to ring making the pilot pickup to answer. ESD events in the control tower of an airport causing the computer and other essential equipment to crash. Enough spurious radiation events to require laptops and cell phones to be turned off upon takeoff or landing.

Why am I and hundreds of others trusting out lives on something so ... sensitive? But we think nothing of dialling up the cell phone inside a car packed with digital controls for things like the brakes, the accelerator, gas control ... The automobile industry does its best to test for the severest of electrical events with lightning simulations. But what about internal to the car less than a meter away? And by the way, do they allow cell phones and laptops in that airport control tower? Do they have conductive floors and require people to wear ESD proof shoes? Define safety related issues? Does it necessarily have to do with physical safety? How about the spurious radiation from an ATM being decoded by someone nearby to gain access to your bank account to drain it?

(Posted by Doug McKean on emc-pstc@ieee.org, 2nd Jan 2002)

171) Some examples of interference in residential environments

EMC? Ha! I've replaced the incandescent lamp on my bedside table with a new energy-saving compact fluorescent lamp. With the lamp on, I cannot listen to even the strongest AM radio station on my clock radio (on the same bedside table) due to the lamp interference. This must not be the usage contemplated by EMC requirements.

My TV and stereo are more-or-less integrated (they are in close proximity). On New Year's Day, I wanted to listen to the radio version of the football game description while watching the TV. With the TV on, I cannot listen to even the strongest AM radio station due to the TV interference. This must not be the usage contemplated by EMC requirements.

I take my Grundig portable radio with me when I travel. Most hotels have sufficient interference sources that I cannot listen to AM radio, and sometimes not even FM radio (with lights and TV off!). This must not be the usage contemplated by EMC requirements. EMC? Ha!

(Posted by Rich Nute on emc-pstc@ieee.org, 3rd Jan 2002. Rich is based in the USA.)

I have it from a message on the RFI@contesting.com list that Phillips bulbs produce less RF noise than others. I can't vouch for that, however.

(One of the replies to the above, from Cortland Richmond, 3rd Jan 02)

172) An example of the 'Pin 1 Problem' causing interference in professional audio systems

The Sound Dept. was asked to design sound effects for a fairly standard play. To deliver the sound effects, sixteen amplifier/loudspeaker positions were required, six of them on stage. All went well during the rehearsals and during the first day of production. The sound designer seemed to have done a good job, so I went back to my office to plan a touring season. But on the second day of production, I was summoned to the stage by the director of the play. His artists could not concentrate on what they were doing because of loud clicks coming from the on-stage loudspeakers.

Sure enough, every time someone used the lift to and from the fly floor, a loud noise could be heard in every loudspeaker on the stage. The problem was traced to the input cables for the amplifiers. The input cables were neatly taped to the floor, following the line of the set. Unfortunately, the cables ran parallel with the lift power wiring, which was under the stage and out of sight. On inspection it was found that the input cables to the amplifiers ran parallel with the lift wiring for at least seven meters. Every time the lift was used, the magnetic field generated by the switching current, coupled with the amplifier cable shields and the switching noise was injected into the input circuit of each amplifier. When the input cables were re-routed, the noise was reduced, but did not totally disappear.

Some years later I found out why. In each case, the cable shield was only connected to ground at one end. This is still the most common method used for trying to control low frequency noise, such as hum or buzz, for equipment that connects the cable shield to the internal circuit 0V conductor (this is now known as "the pin 1 problem" because the three-pin XLR style connectors used in pro-audio connect the cable screen to pin 1).

Each cable shield was thus an excellent receiving antenna for frequencies whose wavelengths were a small fraction of the cable length. The switching noise was duly induced in the cable shields and the noise currents delivered to the output connectors of the mixing console (the cable shields being disconnected at the amplifier ends), where the noise was injected into the mixing console ground conductors. Thus the switching noise was added to the signals delivered from the mixer to all sixteen power amplifiers.

(From Tony Waldron, Technical Manager of Cadac Electronics Ltd, www.cadac-sound.com, recalling an incident when he was Head of Sound at the Royal National Theatre in 1986.)

173) DECT phone interferes with computer

Today I heard about a case where an ISDN terminal was susceptible to a DECT phone next to it while a 900 MHz GSM did not cause anything. This was in the field, not in test lab. In test lab my experience is that if it passes below 1GHz it also passes above it.

(Posting from Ari Honkala to emc-pstc@ieee.org, 10th Jan 02)

Try putting a mobile phone next to your computer mouse! Even more fun if the computer has speakers!

(One of the replies to the above, from Peter Flowerdew, 10th Jan 02. We recommend making sure all data is backed up on removable media before trying this or other interference experiments on PCs, MACs, or other computers.)

174) Electronic Article Surveillance (EAS) system resets pacemaker

The Japanese Ministry of Health, Labour and Welfare announced that there was a case where the operation of a heart pacemaker was influenced by the electromagnetic field from an anti-pilferage device when the patient walked through the exit of a library. Fortunately, the effect was to reset the personalised parameters in the pacemaker to the initial (non-personalised) settings, and the patient didn't feel discomfort with that.

The ministry believes that risk of hazard caused by electromagnetic interference between pacemakers and anti-pilferage devices is low, and a recommendation to the patients was not to stay long time near anti-pilferage devices. The information source was: articles on newspapers (Asahi, Yomiuri, Mainichi, etc.) at 17 January 2002, and Pharmaceuticals and Medical Devices Safety Information No.173 (January 2002) from the ministry.

(From: Tom Sato, 19th Jan 02. Tom's website http://homepage3.nifty.com/tsato/ is a great source of EMC information in Japanese.)

175) Digital cell phones interfere more with pacemakers than older analogue types

Scientific studies have reported increased interference effects in pacemakers caused by digital phones that did not occur with the older analog technology. Cell phones have decreased in size so that they are often carried in a shirt pocket directly adjacent to an implanted medical device. There are a number of wireless technologies in use today which involve different combinations of power levels and modulation schemes.

(From "Immunity testing for Active Implantable Cardiovascular Devices" *by Daniel D. Hoolihan of Hoolihan EMC Consulting, http://www.emcxpert.com, ITEM 2001, p45, www.interferencetechnology.com.)*

176) Financial risks of poor power quality (1)

The inability to trade can result in large losses that far exceed the cost of the operation. In a recent example a claim for £10m compensation was made as a result of a 20 minute power interruption.

(From "Introduction to Power Quality" *by David Chapman of the Copper Development Association, in "The Power Quality and Application Guide", published by The Power Quality Partnership at http://www.cda.org.uk/PQP/pqag.htm.)*

177) Financial risks of poor power quality (2)

It is estimated that power quality problems cost industry and commerce in the EU about €10 billion per annum while expenditure on preventative measures is less than 5% of this.

(From "The Cost of Poor Power Quality" *by David Chapman of the Copper Development Association, in "The Power Quality and Application Guide", published by The Power Quality Partnership at http://www.cda.org.uk/PQP/pqag.htm.)*

178) Financial risks of poor power quality (3)

There are no official statistics on the severity and distribution of voltage dips but some medium scale measurements are now in progress and can be expected to yield valuable information in due course. One study, carried out by a major generator, measured voltage disturbances at 12 sites with demand between 5 and 30MVA.

In a ten-month period 858 disturbances were logged, 42 of which resulted in disruption and manufacturing loss. Although all 12 sites were low technology manufacturing operations making low added value products the financial loss totalled €600,000 (average €14,300 per event or €50,000 per site), with the highest individual loss of €165,000. The table below gives some typical values:

Industry	Typical financial loss per event
Semiconductor production	€3,800,000
Financial trading	€6,000,000 per hour
Computer centre	€750,000
Telecommunication centre	€30,000 per minute
Steel works	€350,000
Glass industry	€250,000

(From "The Cost of Poor Power Quality" *by David Chapman of the Copper Development Association, in "The Power Quality and Application Guide", published by The Power Quality Partnership at http://www.cda.org.uk/PQP/pqag.htm.)*

179) Adjacent channel interference problems with U.S. emergency services' radiocom system

In the USA, many of the emergency services (fire, police, ambulance, etc.) use a radio system which operates at 800MHz. The base-stations for these systems are often quite widely spread, to reduce the cost to the public purse. These systems are known to suffer from 'adjacent-channel' interference, which seems to be on the increase due to crowding of the spectrum. The interference has resulted in documented cases where officers or other have been put at risk. The main problem appears to be intermodulation in the RF front-ends of the handsets, caused by out-of-band signals from other licensed transmitters.

It is often forgotten that most radio receivers achieved their narrow channel bandwidths in the intermediate frequency processing stages, and that the bandwidth of the earlier stages is much wider, making them prone to interference from powerful signals at nearby frequencies.

*(Taken from: "*Interference to Public Safety 800MHz Radio Systems, Interim Report to the FCC, Dec 24, 2001*" which can be downloaded from http://www.apco911.org/afc/project_39/interim_report.pdf)*

180) Locked BMW interferes with digital TV

Question: When my BMW 330Ci is locked, it causes interference to my digital TV service - despite being parked about 30ft from the dish. My wife's Mercedes-Benz doesn't cause this, no matter where it is parked. I was thinking of swapping her Merc for an X5, but two BMWs parked on the drive at once might limit my evening's entertainment to Scrabble. I'm sure I could get the dish moved, at a cost, but I shouldn't need to do that. I.B., via email.

Reply: There is an EC directive about electronic interference that came into force several years ago. Either your car's alarm immobiliser system or the dish/TV receiver does not conform to it.

(Honest John's Agony column, Daily Telegraph Motoring Section, Saturday 30/03/2002, page 10, www.telegraph.co.uk.)

181) Two navy warships nearly collided when the radar of one disabled the steering of another

The minehunter HMAS Huon went out of control and veered across the bow of the frigate HMAS Anzac. Huon – the first of six state-of-the-art coastal minehunters – lost its steering as a result of electromagnetic interference (EMI) from Anzac and passed ahead of the frigate "at close range" according to an Auditor-General's report last week. The previously unreported incident occurred in June 2000 while the warships were sailing to Singapore.

The near-collision was used in the Australian National Audit Office report to highlight shortcomings in the testing and evaluation of new defence equipment, especially in the navy, leading to the installation of only partially tested systems. "The incident prompts questions concerning the adequacy of EMI testing during developmental testing and evaluation and whether the services should complete more extensive operational testing and evaluation before integrating new platforms into defence exercises," the report stated.

The ANAO report rejected Defence Department claims that such testing was expensive and not necessarily cost-effective and said that T&E (testing and evaluation) should be conducted as early as possible in order that risks could be reduced before they became dangerous. "In extreme cases, inadequate T&E could have tragic consequences," the report said.

*(Extracted from "*Loose radar blips nearly sink ships*" by Wayne Smith, The Courier Mail (Brisbane, Queensland, Australia) Friday February 1st 2002, sent in by Chris Zombolas of EMC Technologies Pty Ltd, Melbourne, Australia, March 2002, www.emctech.com.au.)*

182) Experiences of interference in U.S. residential environments

Currently, appliances in the U.S. do not need to meet any EMC compliance standards. Since U.S. appliance manufacturers can (and do) produce domestically used products without any regard for EMI suppression, how serious is the EMC problem in the U.S.? It's difficult to know the entire scope of the problem, but a few examples have come to our attention. For example, the new 2.4GHz portable phones will not function near laundry rooms when certain models of washing machines are running. This problem is easily overcome by not using these portables near these washers. A little inconvenient, but not intolerable.

In another case, a company that imports and distributes microwave ovens asked us to investigate complaints that some of their microwave ovens were turning on by themselves. The cause was a surge on the power line, probably caused by the air conditioning system turning on. The solution was not simple and required units to be recalled and fitted with a hardware and software modification. The costly remedy was necessary because, in this case, the susceptibility of the appliance electronics created a safety hazard.

In Europe, EMC issues will continue to be managed through the existing EMC Directive, so European manufacturers will remain quite familiar with designing and developing next-generation products that are EMC compliant. Without such a directive here, U.S. manufacturers will need to institute good EMC practices to ensure a more EMC friendly environment for smart, networked appliances.

*(Extracted from "*Smart Appliances and EMC – Good EMC practices necessary to prevent smart homes from being chaotic homes*" by Nissen Isakov, president of LCR Electronics, Norristown, Pa. USA, writing in Appliance Manufacturer magazine, March 2002 issue, pages 16-17.)*

183) Examples of interference problems with automobiles

More electronics means more risk from externally generated electromagnetic interference (EMI) and from EMI generated by systems in the vehicle that are adjacent or interconnected. The effects can be quite serious: on certain highway overpasses in Europe, the engines of some vehicles have been shut off when their control units encountered high EMI levels from, among other things, high-voltage lines beneath the roadway, reported David Ladd. He is communications manager at Siemens VDO Automotive (Auburn Hills, Mich., USA), which operates an electromagnetic compliance testing lab. "These problems must be identified and corrected before the vehicle goes into production," he emphasized.

Because of these risks, the auto industry is re-evaluating its requirements and testing for new sources of EMI. Suppliers are increasingly relied upon to develop expertise in managing potential risks during the early stages of engine control unit development, noted Ladd. And the growing use of optical-fibre databuses is eliminating one possible source of EMI problems.

*(Extracted from "*Can you trust your car?*" by Ivan Berger, Contributing Editor, IEEE Spectrum, April 2002, pp41-45.)*

184) CB radio used to intentionally jam early electronic ignition systems

It reminds me of a weakness of the original Bosch "Jetronic" electronic injection system as used as OEM equipment on various European cars in the late 1960s to mid 1970s (this was at a time when the good ol' carburetted American V8 was still the norm here).

A common stunt was that people with (illegal) 50 Watt transmitter boosters attached to their CB radio, would drive up beside a Bosch-injected VW or Volvo or whatever, toot the horn to get the driver's attention, then hold up the CB's microphone for the guy to see, and (with a flourish) key the transmitter. The injection system in the "victim's" car would immediately stop and his car would die until the transmitter was keyed off! Now, THAT'S EMI susceptibility!

*(Extracted from a posting on emc-pstc@ieee.org in the thread: "*RE: Automotive standards*" by Bob Wilson of Vancouver, 5th April 2002.)*

185) Magnetic fields near to mains transformers

Take a large poorly built transformer or solenoid and push the core hard up against the equipment housing and you could well exceed 0.7mT nearby. Several metres from a train *(0.7mT)* is less likely but not impossible. These figures should be borne in mind the next time you read about the dangers of the magnetic fields from overhead power lines. I have several times seen building site welders sitting on their transformers with their testicles dangling over the gap and I haven't seen welders dropping like flies.

(Extracted from a posting on emc-pstc@ieee.org in the thread: "RE: Teslars??" by Nick Rouse, 8th February 2002).

186) NASA report on aviation incidents involving passenger electronic devices (PEDs)

NASA runs an Aviation Safety Reporting System (ASRS) to which pilots and other aircrew can voluntarily report incidents. On 1st May 2002 they released a report of 50 incidents taken from the ASRS which involve the use of Passenger Electronic Devices (PEDs), but not all of the reported incidents concern electromagnetic interference.

This report is very useful when you need to show people that some PEDs can interfere with some aircraft systems and communications. You can download it from: http://asrs.arc.nasa.gov/report_sets/ped.pdf.

(*From Gary Fenical of Laird Technologies, USA, www.lairdtech.com*)

187) One of the aviation incidents reported in the NASA ASRS PED report (see item 186 above)…

Aircraft: DC9. While at cruise FLT FL3100 we noted the onset of multiple anomalies with independent and interrelated onboard electronic systems. The radar altimeter began flagging and sweeping, the GPWS and TASCII annunciated 'FAIL', the VORS flagged, despite good idents and, by and large, rational signals.

Tests of the equip were otherwise satisfactory so we made announcements requesting that certain PEDs (cellphones, pagers, TVs and radios) be verified in a depowered condition, and the flight attendants did a 'PED Walk' in the cabin. The problems initially vanished but then reappeared, and we repeated the process this time requesting that all PEDs be depowered.

The 3rd and final PED walk revealed that several pagers had to be depowered by battery removal, and there was a computer in use with an external battery pack. (No incoming calls to pagers were admitted to.) After this, the anomalous indication vanished for good and all systems operated normally (including the GND VOT signals).

188) Another aviation incident taken from the NASA ASRS PED report (see item 186 above)…

Aircraft: DC9. During CLBOUT from BDL, the captain's radar altimeter flagged and the TCASII and GPWS subsequently annunciated 'FAIL'. The problem continued throughout the CLB to FL350 whereupon I had time to ask a flight attendant to do a PAX electronic device walk. She discovered that a Sony Video Walkman was in use in seat XX. After the Sony was shut off, the problems cleared up. The item was a Sony GVA-500 Video Walkman.

189) Just one more aviation incident taken from the NASA ASRS PED report (see item 186 above)…

Aircraft: Brasilia EMB120. I experienced interference with VOR navigation reception. We found a PAX in seat XA operating a 300MHz Toshiba Protégé Laptop computer. We had her discontinue the use of the computer and normal reception was restored. I have had previous problems with Toshiba computers that are used in row X. I will not limit the use of PAX electronic devices yet, however I now immediately check to se if a laptop is on when experiencing navigation problems.

Callback conversation with the reporter revealed the following info: the reporter stated that the same exact incident happened on a different EMB120 at row X and with a Toshiba laptop computer. That time, they were at McAllister VOR, when the needles on the MFD (Multifunction display) went crazy and were spinning in circles. In both cases, it was spinning in circles on both NAV1 and NAV2. The reporter guessed it was a laptop computer causing it and had the flight attendant check it out and had the person turn it back on to see what would happen, and the instruments resumed almost a normal position , but it was 40 degrees off from ATC.

He said row X is the first row behind the trailing edge of the wing. With this particular incident, he is 90 percent sure that the PAX did turn her computer back on afterwards, but they were almost on top of the new VOR, so he believes that's why it didn't interfere again with the navigation. The reporter speculates that perhaps the Toshiba laptop computer and the VOR had the same or similar frequencies.

190) Pop-up toasters in Dorset speak Russian

Villagers in Dorset were baffled when their pop-up toasters began to speak Russian. Phones and other electrical appliances in Hooke also chatter away in foreign languages and play music. The phenomenon has been blamed on a powerful radio transmitter in nearby Rampisham that transmits BBC World Service.

John Dalton, chairman of the parish council, says: "I've heard foreign voices through an electric organ. And I was amazed when I got the World Service signature tune through a toaster".

(*From "*Weirdness of the Week*" in the Sunday Times' 'News Review', 12th May 2002, page 4.12, www.sunday-times.co.uk.*)

191) ITV Digital alleged killed by government restrictions on transmitter power

"The basic problem was that the black boxes didn't work. The signal was weak because civil servants were frightened to interfere with signals for conventional television and mobile phones. So screens would go fuzzy during a drama's crucial kiss or freeze just before the winning goal." Green groans. "This is not an excuse but if I did it again, I would check all the technology worked first.

We were promised extensive coverage but it was like Swiss cheese. One side of the street would receive a signal but not the other. It made marketing hopeless. When I went into my local Dixons in the country, they said that I couldn't get digital but my box worked fine. Its remarkable we got 1.2 million viewers, it was such a farce."

Didn't he try to get the signal turned up? "There is no question but that this Government was useless. I went so many times to Chris Smith, Tessa Jowell, and Tony Blair, saying: 'We're losing £1 million a day, please turn up the signal. You never told us it wouldn't work: it's softer than an electric razor.' The Government shouldn't have to interfere but they sold us a dud product."

(*From "*Is ITV Digital a mess? Yes. Did we make mistakes? Definitely*", an interview with Michael Green, chairman of Carlton Communications in The Daily Telegraph, Saturday May 4th 2002, Page 10, www.telegraph.co.uk. This was just after ITV Digital closed down with a financial loss of about £600 million with 1700 people losing their jobs.*)

192) More on the demise of ITV Digital

The main problem with ITV Digital is that its technology did not work. It was inferior to rival offerings from satellite and cable. The signal had to be transmitted at low strength, otherwise it interfered with mobile phones and even French television. The result was only half the country was covered, and the service was unreliable.

The Government failed to sort out the different regulators, such as the Radio Authority and the Radio Communications Agency, which dragged their feet in allowing ITV Digital to turn up its signal.

(*Two extracts from "*How the digital dream became a nightmare*", The Daily Telegraph, Saturday May 4th 2002, page 11, www.telegraph.co.uk.*)

193) Walkie talkie interferes with gas detector, puts lives at risk

A portable gas detector failed without the operator noticing when used near a handheld radio transmitter. The equipment was being used to protect people involved with sewer repair work from the effects of toxic gases. The electric field strength from the transmitter may locally have exceeded the proposed (*at that time - Editor*) industrial generic immunity level of 10 V/m. This is an example where equipment, which may have conformed to a standard, was apparently not immune to interference in use. It was subsequently modified to include an additional screen.

(*From "Dangers of Interference, EMC and Safety" by Simon Brown of the UK's Health and Safety Executive, in the IEE Review's EMC Supplement July 1994 page S-11, www.theiet.org.*)

194) Poorly bonded aircraft surfaces cause loss of navigation and communication in rain (1)

A pilot complained about navigation and communication equipment on his plane becoming inoperable when flying through rain. Studies have shown that when an aircraft flies through rain, static electricity on the aircraft skin can exceed 100,000 volts. In the hanger, testers simulated this situation by isolating the aircraft from ground. Using a high voltage power supply they charged the aircraft to approximately 100,000 volts. A portable RF receiver was used to locate the source of broadband RF noise. It turned out to be arcing between poorly bonded aircraft surfaces.

(*From "*The Case for Combining EMC and Environmental Testing*", by W H Parker W Tustin and T Masone, ITEM 2002, pages 54-60, www.interferencetechnology.com.*)

CHERRY CLOUGH CONSULTANTS LTD

195) Poorly bonded aircraft surfaces cause loss of navigation and communication in rain (2)

Author Masone recalls a flight test to document a similar problem. The test involved flying EMI specialists into a storm. Immediately upon entering the storm, Masone heard a high-pitched squealing sound from the pilot's headset. Its intensity was such that the pilot had to remove his headset. The navigation display then went black. All navigation and communication equipment was inoperable in a whiteout condition with freezing rain and snow! Fortunately, the pilot was experienced, and there were no other aircraft in the flight path.

Upon exiting the storm, all navigation and communication functions returned to normal operation. Back at the hangar, high voltage testing led to the discovery of a poor bond between two surfaces on the horizontal stabilizer.

(*From "The case for combining EMC and environmental testing", by W H Parker W Tustin and T Masone, ITEM 2002, pages 54-60, www.interferencetechnology.com.*)

196) Flying too close to radio masts has in the past brought down military aircraft

The system is also immune to electromagnetic interference, unlike other methods of computer control. Flying too close to civilian radio masts, for instance, has in the past brought down military aircraft.

(*From "*Fibre Optics to Aid Helicopter Safety*" by Rob Coppinger, The Engineer, 19 April 2002, page 11, www.theengineer.co.uk.*)

197) Guide on proximity of wireless communications to pacemakers

The Pacemaker Committee of Japan issued the following guidelines at March 1996…Keep handy cellphones (and PHS, cordless phones, etc.) away at least 22cm from the implanted pacemakers. When using such devices, patient should use the ear at the opposite side of his pacemaker. Stay at least 30cm from antennas of land mobile radiotelephones and shoulder radiotelephones. Patients shouldn't use other radio transmitters such as amateur radios, walkie-talkies (excluding that with extra-low power), etc. This committee is a conference group in Japan Association of Medical Equipment Industries (JAMEI).

The criteria was also referred in a guideline issued by the Electromagnetic Compatibility Conference Japan. I found the Japanese text of the guideline on the Internet, at http://www.medtronic.co.jp/ja/misc/keitai.html (it seems JAMEI itself doesn't publish any information on the Internet), but I couldn't find the English version of the guideline.

(*From Tom Sato, Jun 02. Tom's website http://homepage3.nifty.com/tsato/ is a great source of EMC information in Japanese.*)

198) Fluorescent lamp interferes strongly with AM and FM radio

Was just at a cheesy hotel with the replacement circular fluorescent lamps directly above (2 feet) the hotel-provided radio (less cheesy than most). Turning on the light completely destroyed the signal. AM and FM and all channels. Turn it off and the radio was nice and clear. Wanted to steal the bulb to measure later - decided on the towels instead. Not only should these bulbs have not been CE marked, they should have had a label for use only inside microwave ovens or something.

(*From Gary McInturff, 24th April 02, in a thread on "CE for Fluorescent Lamps" on the IEEE's emc-pstc discussion list.*)

199) CE marked keyboard fails ESD tests

Well, I've stumbled over one of my pet peeves again. We had a combination keyboard/touchpad (CE marked) which failed ESD testing a couple of months ago. It would either give false inputs or become unresponsive when 8KV air discharges were made to the touchpad. I tried ferrites at both ends of the cable...no luck. Since we don't make the keyboard, I can't open it up and make changes (although I would like to open it up with a sledgehammer...that would make some changes).

So, we bought another brand. This one has a keyboard and trackball. Our hope was that the trackball would be more zap-proof than the touch pad....No dice...snap, crackle, pop it fails too. Oh, by the way, this keyboard was prominently CE marked as well.

(*From Chris Maxwell, 19th April 2002, in a thread on "Suitable CDN for IEC61000-4-6 ethernet 10/100" on the IEEE's emc-pstc discussion list.*)

200) The most spectacular 'banana skin' of all times!

In 1899 (!) in Colorado Springs Nikola Tesla himself tested his tesla coil.

He did not use filters, the harmonics burned out the wiring in the power company in Colorado Springs.

(*We like to celebrate each 100th Banana Skin with a funny or off-beat item. This one was sent in by Geert Starre on the 14th May 2002.*)

201) Potential safety implications of mobile phones and aircraft, with examples

Please could you help with a project I have, investigating potential safety implications of mobile phones and aircraft. Three potential hazards come to mind.

1). While using mobile phones on the ground, whilst refuelling the aircraft, the displacement of air at a rate of approx. 1500 lt. per minute out of the tanks as vapour spill from vents at the wing tips. They are not intrinsically safe, so what energy is required to ignite fuel vapour? (I have personal experience of seeing the results of a person with a mobile phone strapped to his belt while filling his petrol tank. The mobile rang, igniting the vapour, and causing a jet bast from the tank which unfortunately took all the skin off from his wrist to his elbow).

2). Batteries should one become damaged and or shorted causing a fire what would be the possible fire hazard and what extinguishant should be used?

3). Potentially the worst case scenario RF break through from the mobile into the systems. They often can be heard over radios when transmitting in the vicinity of the receiver, a unwanted signal in my view, therefore what could happen if the signal is induced into and reacted upon in one of the many other systems? Again personal experience has shown of signals in an industrial process line where a 3 watt transceiver was being used some 15 meters from a large electronic motor control center, which sent motors into random speeds simultaneously causing major stoppages for the process line and months of these random transients to get solved. From an aircraft's point of view I have experienced transmitting from the aircraft's fitted VHF Transmitter on a particular frequency and the aircraft pitching nose down some 20deg while the autopilot was being used.

(A query made by Paul Barnes to an IIE Special Interest Group on the 2nd February 2002.)

202) Vacuum cleaner interferes with computer terminals

One of my first business trips after I got out of college was going to Chemical Bank in New York City, because one of the Sycor 250 terminals (for which I had written the firmware) would lock up every night. The hardware designer and I installed some hardware and software monitors on this unit, and left for the evening. Next morning we returned, and discovered that it had died shortly after 11pm-- the very time that the cleaning people were making their rounds!

We discovered that the cleaning people were plugging their industrial vacuum cleaners into the same wall outlet as our terminal because it was convenient. I think that the bank changed to a simplex wall outlet there, and that solved the problem.

(John Barnes, dBi Corporation, from a thread entitled Re: Voltage Spikes on Power Lines etc on emc-pstc on 14/03/02 23:14:43, www.dbicorporation.com.)

203) Indoor equipment needs to withstand 6kV spikes on the mains, for reliability

I discuss problems with powerline-spikes in chapter 8, Designing Power Supplies, of my book Electronic System Design: Interference and Noise Control Techniques (Prentice-Hall, 1987, now out of print).

For equipment that will be used indoors, you should try to design your equipment to be immune to 6kV spikes. That is approximately the voltage at which our wall outlets arc over.

(John Barnes, from the same thread as item 202 above)

204) Tracing aviation frequency interference in Miami to illegal cordless telephones

The Enforcement Bureau of the FCC is taking strong action against retailers who are illegally marketing non-compliant equipment, specifically long-range cordless telephones. The Commission has initiated action against New Image Electronics (NIE), a Miami, Florida electronics store, for selling long-range cordless phones designed to operate on civil aviation frequencies.

The agency's action followed a six month investigation that began in February, 2001 when the FCC's Enforcement Bureau received reports from the Federal Aviation Administration (FAA) of sporadic, but potentially harmful, interference to aviation frequencies in the Miami area. FCC agents traced the interference to NIE, and investigators visited the store on at least two separate occasions, actually purchasing a long-range cordless telephone during its second visit. Not surprisingly, the purchased phone possessed none of the labeling or FCC authorization required for marketing the device in the United States.

In its response to the Commission, NIE did not deny that it had sold the phone to the FCC's agents, but claimed in its defense that their clerk had mistakenly believed that the phone was being sold for export when one of the agents gave his address as "Puerto Rico." In its forfeiture decision, the FCC noted that Puerto Rico *is* part of the United States.

The Federal Communications Commission (FCC) has also taken action against two other Miami-based retailers for illegally selling long-distance cordless telephones. The Commission has issued monetary forfeitures to Electronics Unlimited and Lightning Electronics for the illegal marketing of non-compliant, high-powered cordless phones.

(From Curtis-Straus Update for April 2002, via Conformity Magazine, www.conformity.com.)

205) Example of bad EMC practice - connecting cable screen to circuit 0V instead of enclosure

I was asked to do EMC tests on a multi-channel digital location recorder designed and built by the R&D department of a well-known record manufacturer. The recorder was housed in a 19" rack unit and controlled by software running on a laptop computer, via RS 422. The audio results were said to be excellent, but they invariably had problems with the control functions. On the last recording session, the machine went into record mode as requested, but during the session, control of the recorder was lost. No command would allow the engineers to stop the machine or come out of record mode. The whole system had to be re-booted before they got control back. This was a classical orchestral session with 80 musicians, so the problem could have been expensive.

I placed the recorder unit in the EMC test chamber, connecting the system up normally, but with the laptop computer outside in the control area. This was to isolate the two different parts of the system. The recorder unit passed the basic emission tests when running in record or playback mode on its own. But when the RS 422 line was connected between the laptop computer and the recorder rack, the system failed the radiated emission test by a wide margin.

If the RS 422 cable radiated interference, it was very likely that the same cable would receive interference. I set up for the conducted immunity test. The cable, carrying signal or control data, is bombarded with a known level of RF from a computer-controlled oscillator/power amplifier, with the generated RF modulated by a 1kHz sine wave. The equipment under test is monitored to check if interference to the wanted signal can be detected in the main signal path or on the control data. Since the problems with the recorder involved the control data, we decided to test the RS 422 cable first.

The RF oscillator automatically sweeps through the test frequency range under computer control. Any problem that occurs is picked up by a volt meter/detector and logged in the test file. If necessary, fault events can be manually entered via the computer keyboard. The recorder unit was put into record mode and I started the test. At first all went well. But, as the modulated frequency approached 8 MHz, the time code display on the laptop screen stopped. All other controls seemed still to be working. However, at about 16 MHz, a second event was detected, and the laptop had lost control of the recorder unit. The recorder was permanently in record mode! I put the EMC test system in pause, and rebooted the recorder and laptop. Restarting the test at 18 MHz, everything was working properly until the modulated RF approached 33MHz (the bus/processor frequency of the recorder electronics). Multiple events were detected and control of the recorder system was lost once more and the laptop crashed. To cut a long series of tests short (similar problems were encountered on the other side of the recorder’s processor/bus frequency) - the problem was obviously interference on the RS 422 data communication circuit. But how could this be the case? RS 422 is a balanced transmission system and the cable was shielded.

An inspection of the RS 422 connectors at each end of the circuit revealed the following:

- The connector at the laptop end had the cable shield correctly bonded to the chassis.
- The connector at the recorder unit end was an insulated component. The cable shield connection was wired directly to the logic 0V track on the printed circuit board (the digital version of the pin 1 problem).
- The custom made RS 422 cable had the cable shield connected to the recorder unit end only. The cable was constructed in this way, because the engineers had found that hum was introduced into the recorder when the RS422 cable was connected to the standard desktop PC used during the design phase of the project.

Thus, any interference current induced into the cable shield of the RS 422 data communication circuit was injected directly into the recorder unit's ground conductor, allowing interference currents to flow in the RS 422 I/O electronics, resulting in poor or bad data on the RS 422 communications circuit. The laptop (or any other) computer, **and** the recorder was, at the very least compromised, by any interference induced on the RS 422 cable shield.

(From Tony Waldron, 8th Jan 02)

206) ESD problems with CE-marked keypads and mouses

Dear Ann Landers. I've always had trouble with peripherals. Keyboards and mice that were CE marked and looked like such good prospects have mostly turned out to be fickle. Well, I've been involved with a touchpad for about five months now. When I first bought it, we were so happy. Whenever we were together it, it could read my mind. A tap of my finger and it knew just what to do. And then this ESD gun comes along. One zap and BOOM! The touchpad turns its back on me. It won't respond at all! I tried talking to it...but it just gave me the cold shoulder. I suggested counseling...still no response. I threatened to go and get a mouse...no response. Well, I finally had to just take a deep breath and go through with it. I cycled power. Well it now responds to me... but I don't know if I'll ever trust it around an ESD gun again. I don't know if our relationship will ever be the same. Signed "Out of touch in New York"

OK, OK, the real question is... does anybody have some words of advice regarding touchpads. I am testing a unit which consists of a keyboard/touchpad combination. The touchpad is approx 1.5" x 1.5" and is able to sense a sliding or tapping finger. The touchpad is used to perform all of the functions that a mouse typically performs. I am assuming that it has some sort of capacitive sense circuit which can tell when your finger slides across the pad or taps on the pad. I have one that gets all out of whack with 8KV ESD. i.e. the touchpad becomes unresponsive and it stops software execution in our host system.

Unfortunately, this is one of those instances where we don't build the keyboard/touchpad; so my bag of fix tricks is limited. Probably limited to seeing if another manufacturer produces a keyboard/touchpad with better performance. Or, am I slamming my head against the wall on this one? The keyboard/touchpad is already CE marked by its manufacturer. Is his typical? Are all touchpads (even CE marked ones) ESD sensitive? Do I just live with it? Am I over-testing this touchpad?

Overall... I have had REALLY bad experiences with CE marked keyboards and mouses. Now I have trouble with our first touchpad. We typically use a capacitive filter on our inputs and we typically put a ferrite on the cable...yet still trouble. Is this typical of what others see?

(From Chris Maxwell 02/01/02 21:56:34 via emc-pstc. Note: Ann Landers is a U.S. magazine's well-known 'Agony Aunt'.)

207) Interference and jamming threats to GPS

Over the past couple of years, there has been extensive discussions of the potential interference that ultra-wideband (UWB) radio signals might cause to GPS once UWB devices proliferate across the planet. But GPS is also susceptible to interference from more conventional transmissions both accidental and intentional (jamming). For example, a particular directional television receiving antenna widely available in the consumer market contains an amplifier which can emit spurious radiation in the GPS L1 frequency band with sufficient power to interfere with GPS reception at distances of 200 meters or more.

Harmonic emissions from high-power television transmitters might also be a threat to GPS. Furthermore, the GPS L2 frequency is susceptible to interference from out-of-band signals from transmitters operating in the lower part of the 1240 to 1300 MHz band which is shared by terrestrial radiolocation services and amateur radio operators. As for intentional interference, the weak GPS signals can be readily jammed either by hostile forces during conflicts or by hackers who could easily construct a GPS jammer from a surplus home-satellite receiver.

I have experienced the effects if RFI on GPS in Germany and some neighbouring countries since 1995. During this time I only experienced RFI to the GPS L1 frequency twice. In 1997 near the Swiss airport of Lugano, signals emitted from a permanent transmitter operated by the Italian military were detected (see Figure 3). In February 2002, for 20 to 30 seconds an unknown interfering signal with a frequency of 1570.96 MHz disturbed the reception of L1 at Frankfurt Airport and surrounding areas up to a distance of 150 kilometres (see Figure 4).

While Geodetic receivers exhibited a loss-of-lock, a certified aviation receiver merely experienced a degradation of the S/N. Dual-frequency GPS users routinely detect interference to the GPS L2 frequency in Germany, Switzerland, and The Netherlands. In all cases the sources are amateur packet radio transmitters in the frequency band between 1240 and 1243.25 MHz.

Such transmitters are called "digipeaters" (short for digital repeaters or relays). They are part of a Europe-wide network of a kind of wireless Internet operated by radio amateurs (see Figure 5). They cause interference to dual-frequency GPS receivers operated by researchers at several universities as well as by geodesists and surveyors. Figure 6 shows a comparison of the spectrum of such signals with a susceptibility curve representing the interference power required to degrade the S/N by 10dB.

(*Two extracts from the text of: "*A Growing Concern – Radiofrequency Interference and GPS*" by Dr-Ing Felix Butsch of Deutsche Flugsicherung GmbH (DFS) in GPS World, October 2002, pages 40 - 50.*)

208) Broadband over power lines – interference concerns

Early field trials in UK, Germany and Switzerland showed excessive radiated emissions (up to 40dB) above NB30 RegTP limits, which are about 20dB more relaxed over the 4/2000 RA version of UK MPT 1570 in the short wave spectrum. Broadcast, military, commercial as well as licensed amateur radio services started seriously objecting to a nationwide implementation of PLC. (*PLC = Power Line Communications, basically sending Internet data over existing mains wiring and cables – sometimes called PLT instead – Editor*)

Far field effects and underestimated PLC system antenna factors [10] lead to short wave signal mirroring at the ionosphere. That is today not at all taken into account by officials in the ministry of economy in Berlin, which supervises the RegTP agency, the equivalent to the FCC US. These sky wave propagation effects might lead to background noise increase [6][7][10] also outside Europe. Sensitive receiving sites in Germany may experience, based on first simulations, degradations of 10 to 40dB! This is unacceptable for security agencies in the present political scenario.

The introduction of power reduction in broadcasting, due to digital technologies, reducing transmit power and therefore lowering electromagnetic pollution or heath hazards, become useless if at the same time the signal noise ratio will be PLC degraded.

Reports on publicly available, new measurements data from PLC modems/systems (e.g. ASCOM). Some indicating serious legal and technical trouble in wide spread PLC field trials systems.

Suspicion arouses, due to questionable promoter companies, seemingly forcing contracts with non-discloser agreements to be signed by their clients. This could hamper independent measurements.

Everybody is fighting physics. Due to Shannon, signal to noise ratio (typ. 15dB) is EMI relevant. PLC signal level, modulation and existing line noise are important to bridge the distance without costly repeaters. The PLC community is therefore fighting for "better"? less stringent regulations and want new EMC standards.

Little attention was formerly given to commercial System EMC; box testing was rather dominant. Finally, the commercial EMC community is forced into System Thinking! Cable TV systems started interfering with air traffic control over major German cities.

Typical test problems are identifying PLC Interference in bands <30 MHz, receiver jamming, time variant EMI. It takes wireless experts to be sure it is PLC and not other EMI. Normally at CW, AM, SSB, the whole receive spectrum is experiencing a massive noise floor increase (sounds like an old steam locomotive sometimes), resulting in total blocking. The sensitivity is wiped out.

Generally speaking there is very little willingness of the PLC people to talk technical even today.

On the official side, however, 100 serious, professional NB30 objections, some demanding even lower limits, filed to RegTP, were politically ignored by the ministry of economic affairs last year when NB30 came out. Reliable sources indicate, Federal Cabinet Minister Mueller (Economy) – originating from RWE (*a company which is active in the PLC business – Editor*) – before entering his political career in the SPD government – wants to return to his old company!

(*A number of extracts from: "*Update on Power Line Telecommunication (PLT) Activities in Europe*" by Diethard Hansen of Euro EMC Services (EES) www.euro-emc-service.co.de, chairman of ATRT WG PLC, RegTP, Germany, presented at the IEEE's International EMC Symposium held in Minneapolis, Minnesota, August 19-23 2002, and published in the Symposium Record on pages 17 - 22.*)

209) Increasing pollution of electromagnetic environments

Array-pattern nulling effects have become an important field of study recently due to the increased pollution of electromagnetic (EM) environments. These techniques reduce degradation of signal-to-noise ratio (SNR) performance due to undesired interference in radar, sonar, and communications systems.

(*Taken from "Reduce SNR Degradation in EM Environments Using a Nulling Technique" on page 56 of Microwaves and RF Journal, September 2002.*)

210) Examples of interference from Douglas Brooks

EMI and RFI are not new phenomena. They are problems that have been around for years. When I was a small boy (which is longer ago than I will admit), I grew up across the street from a ham radio enthusiast named Bob Beebe, W71GM.

Bob had a powerful one-kilowatt linear amplifier for his ham rig, and a rotating beam antenna on his roof that covered more area than his roof did. We could hear him on every electrical appliance we owned. His calls are indelibly etched on my memory: "Hello, CQ, CQ, C. Hello CQ, CQ, CQ. This is W71GM, I Got Manilla." (Manilla was the name of his wife!) Every time we got a new radio, we'd have to call Bob to come over and wrap it in copper or place ground wires all around it in order to shield out his emissions.

In another life I ran a company that made weighing systems for industrial trucks – i.e., scales to make sure trucks were within legal limits. They were portable, could be towed behind a police car on a small trailer, and used portable electronics that plugged into the car's cigarette lighter. They ran off the same electrical system the police radio did, and the indicators were often placed right next to the radio or on the car roof, right next to the antenna. Immunity to RFI was a significant design requirement.

We had just finished a complete redesign of our indicator family. We had access to a screen room facility and a technician through another company, so we went there to do the EMI/RFI testing. During the very first test, however, the indicator went totally off-scale! No matter what we did we could not quiet down the indicator. After two hours of tweaking we got some improvements and then hit a plateau. No matter what we did we could not quiet down the indicator.

The screen room technician finally spoke up and asked us what the input circuit looked like. We told him it was a high-gain differential amplifier, which then fed an A/D converter. He asked us what part number the amplifier was. We told him. It was a commonly available amplifier made by at least four or five manufacturers. He then asked us who manufactured the part. We told him. He then told us that particular manufacturers often had RFI problems with its parts and why didn't we buy the same part from a different vendor. We did, and the RFI problems almost totally went away. It took us only a few more hours to achieve the RFI objective and the product then successfully went into production.

There was no clue in any of the published specification from any of the manufacturers of this part number that there would be differences in RFI sensitivity between product offerings. We had no reason whatsoever to suspect that part. We might have struggled with that design for months if that technician had not put us on the right path. There are two morals to this story:

- A good technician with experience can be more valuable than someone else with all the university degrees in the world.
- There can be subtle differences inside IC packages in otherwise identical parts that may only be determined by laboratory testing or trial.

More than one engineer has been 'burned' by a part that behaved unexpectedly. Sometimes, as in this case, there are simply differences in design or manufacture or otherwise "identical" parts. Sometimes a supplier changes a manufacturing process without telling anyone. Often this involves the implementation of an improved process, which coincidentally may offer faster rise times.

Perhaps the manufacturer thinks that the change or improvement will have no particular consequence for anyone, and treats it as simply an in-line adjustment. But sometimes the faster rise-time results in timing or EMI problems that didn't exist in the user's design before. These can be particularly difficult to trouble-shoot, because people rarely equate the problems with a device, particularly a device that used to work just fine.

(*Extracts from "*Lessons Learned the Wrong Way*" by Douglas Brooks, President of UltraCAD Design Inc., www.ultracad.com, in Printed Circuit Design mag, Sept 2002, pages 30, 39, www.pcdandm.com.*)

211) Transients and noises on mains power supplies cause communications problems

Its an all too familiar scenario. You're on the phone to an important customer, and – far from being able to hear whether he's about to place the biggest order of the year – all you hear is an irritating crackling on the line.

Well, if its any comfort at all, you are not alone. Every year, thousands of users report that their critical business calls have suffered, for some inexplicable reason, from intermittent hissing, buzzing, crackling, and general interference. And when the phone companies investigate the phenomenon, they find nothing wrong. It's a phenomenon that frustrates IT departments, telecoms engineers, sales managers, directors, in fact anyone that has to use a phone for business.

But this understandable annoyance that many of our industries suffer as a result of poor quality voice communications is nothing compared to the potential loss of revenue that can arise if their data systems suffer the same fate. And yes, you'd better believe that this is exactly what too many businesses are experiencing at this very moment.

I'm not suggesting that spikes and surges in the power supply are at the root of each and every problem, there is little doubt that they contribute to a significant number of these anomalies and aberrations. In fact, no lesser source than IBM's Systems Development Division comments that "More than 80% of mains power problems are transient and noise related."

*(Extracts from "*Communication problems – can TVSs provide the answer*?" by Mike Burgoyne of Advance Galatrek, Components in Electronics magazine, Sept 2002, page 28, www.cieonline.co.uk.)*

212) Concerns about threats from electromagnetic pulse weapons

Two individuals have filed a petition with the FCC for reconsideration of a proposal that would require all electronic equipment to be shielded against electromagnetic pulse (EMP). With the prospect of future terrorist attacks clearly on their mind, the petitioners wrote that there is "the need for mandatory shielding to protect vital civilian equipment from the possible hostile use of an Electromagnetic Pulse (EMP)".

(Conformity, October 2002, page 46, www.conformity.com)

213) Kitchen equipment interferes with passenger ferry logging system

Every time the passenger ferry passed a certain point leaving the harbor, the automatic logging system was reset to its default settings. This always happened late in the evening, around 23:00. Strangely enough, this problem never occurred when the ferry was arriving at the harbor. After a thorough investigation, it was found that at 23:00 the stoves and ovens in the kitchens were switched off for the night. The transient overvoltages from the switch-off found their way to the bridge via the signal and power cables on board. The investigations also showed that no cable screens at all were correctly grounded.

The problem with the log was solved by introducing cable feedthroughs with electromagnetic disturbance protection, and by adding transient filters.

*(From Roxtec Ltd, page 23 of its booklet on '*Cable and Pipe Transits for EMC*', December 2002, www.roxtec.co.uk)*

214) Walkie talkie causes oil and gas platform to move, threatening a pipeline break

Offshore oil and gas production platforms present an extremely difficult electromagnetic environment due to the amount of electrical and electronic devices crammed into a small space. In this case, a platform was anchored to the sea bottom, but its exact position was adjusted by thrusters, i.e. large electric motors driving propellers. The position of the platform was controlled by a computer system. The power and control cables, all screened, were routed from the control room on the bridge at the top of the platform, all the way down to the engine rooms far below. However, the cable feedthroughs were not protected against electromagnetic disturbances. Com radios *(i.e. walkie-talkies – Editor)* were used both on board the platform and for communication with land.

When a technician tried to use his com radio in the engine room, the connection was continually bad. By letting the radio antenna touch a cable harness, the connection became much better. By feeding its electromagnetic energy into the cable screens, the radio got a much improved "antenna". Unfortunately, the energy in the cable screens also went elsewhere. It went via the cable screens to the thruster control equipment, which interpreted the energy as a signal for adjusting the position of the platform.

(From Roxtec Ltd, page 22 of its booklet on 'Cable and pipe transits for EMC', December 2002, www.roxtec.co.uk)

215) Intermittent malfunctions in foundry equipment caused by poor EMC design

Bad EMC design caused operating problems in a quality control system in a foundry. The quality control system consisted of two subsystems, a robot subsystem and a measurement subsystem. An industrial robot picked up the heavy metal pieces and placed them at the measurement system. The measurement system checked for the presence of cracks in the metal. The electromagnetic environment was tough, with motor drives, arc-welding equipment and electric forklifts nearby. The problem was intermittent malfunctions in the entire system.

An investigation showed that the two subsystems interfered with each other. The industrial robot subsystem was carefully designed and installed with respect to EMC. The measurement subsystem, however, was not designed or installed with respect to EMC. The industrial robot subsystem was designed in a series of zones, where each zone was screened and equipped with Roxtec EMC cable feedthroughs.

The measurement subsystem was not divided in electromagnetic disturbance protected zones at all. Some of the cables were screened, while others were not. The screened cables entered the control cabinet via a large opening in the cabinet floor. The internal layout of the control cabinet was not done according to EMC principles. By redesigning parts of the measurement subsystem installation, it was possible to bring the operating problems down to an acceptable level.

(From Roxtec Ltd, pages 24-25 of its booklet on 'Cable and pipe transits for EMC', December 2002, www.roxtec.co.uk)

216) Combating satellite interference

A system to combat satellite interference, which costs operators millions each year in lost bandwidth, has been developed in the UK. Qinetiq's satID system is designed to pinpoint ground bases inadvertently transmitting to an operator's satellite, and using up some of their expensive bandwidth. The introduction of satellite services, the growth of personal satellite communications technology and congestion of the geostationary arc are increasing these interference problems, said Dr Rob Rideout, senior scientist for geolocation at Qinetiq.

"Satellites suffer a lot from interference, and as satellite transponder bandwidth is an expensive resource, to have that tied up is a big commercial problem for operators. The cost could run into many millions." The vast majority of satellite interference is not malicious, but results from equipment failure of operator error. "Someone could be operating at the wrong frequency due to an equipment malfunction, or an operator could be pointing at the wrong satellite."

(Taken from an item by Helen Knight in The Engineer, 22 Nov - 5 Dec 2002, Page 11, www.theengineer.co.uk.)

217) Electromagnetic fields in cars

I was very interested in Rob Coppinger's article 'Jaguar tests cars for radiation' (News, 1 March) which reported on Volvo's decision to make adjustments to three of its models after they were found to generate a high level of electromagnetic radiation (EMR). I purchased a new VW Golf – which in common with all modern cars is full of high-tech gadgetry – and found that the electromagnetic fields were some 100–200 times greater than they had been in my old Peugeot.

(Taken from a letter by Andrew Collett, Letters, page 36 of The Engineer, 22 Nov - 5 Dec 2002, www.theengineer.co.uk.)

218) 'Singing' light bulbs and their interference possibilities

Allen Brown (*Letters*, September) asks whether there is any explanation as to why electric light bulbs sometimes 'sing' just before they fail. If a lamp filament fails during use and the break is not sufficient to interrupt the current, an arc will form across the break. Arcs formed in this way can be surprisingly long if the ends of the filament move. The singing is the sound of this discharge, possibly acoustically modified by the thin glass envelope. Therefore filament lamps start to sing when they fail and not before. On a safety note, as this discharge is a UV source it is not advisable to look at a 'singing lamp' in view of the chance of 'arc eye', but to switch it off. If the singing was due to arcing across a break, the lamp will of course not light again.

I first met the 'singing light bulb' effect as a very junior technical assistant in a lampworks in the mid-1930s. Part of my job was to inspect the life-test racks twice daily, perform the BSI 161-1936 specified interruptions in supply, and record failures. Out of several hundred lamps on test, it was not uncommon to find one 'singing'. The explanation is, of course, that the tungsten coil, having suffered long, has now parted at its weakest point and is now arcing using the remains of the tungsten coil as ballast. Left undisturbed it may run for some hours, depending largely upon the pressure and purity of the gas filling.

(These two contributions are from Alan Vicary and William J Chapman respectively, published in the Letters page of the IEE Review November 2002, page 25, www.theiet.org. The Editor wonders whether any RF emissions measurements have ever been made on a 'singing' light bulb – he would expect there to be a significant emissions of broadband disturbances, probably modulated at the audible 'singing' frequency, peaking at the resonant frequencies of the mains wires. Filament light bulbs are often held up as an example of a "passive EM" device, i.e. one causing no electromagnetic emissions and unaffected by electromagnetic disturbances. But 'singing' light bulbs not too uncommon, and it seems that about 1% of ordinary coiled filament light bulbs are VHF transmitters at between 28 and 45MHz – see Banana Skin No. 159.)

219) Examples of interference from the U.S.'s Food and Drug Administration (FDA)

The Food and Drug Administration (FDA) is aware of a safety issue that affects users of all electrical products. Specifically, electromagnetic interference is resulting in hazards to users and operators. Our purpose in writing to you is threefold: 1) to inform you of our involvement, 2) to encourage interchanges between professional and trade associations (medical and non-medical) to develop solutions, 3) to ask you to re-assess your product designs.

We are concerned about the response of electrically-powered products exposed to various electromagnetic environments and the consequences of that response. CDRH has received reports of malfunctions of medical devices and radiation-emitting electronic products due to electromagnetic interference (EMI), including radiated emissions, conducted emissions, and electrostatic discharges. Sometimes, the consequences were severe even though emissions were within currently accepted limits; for example:

- a monitor failed to detect a patient's critical condition,
- a defibrillator failed to resuscitate a patient,
- a wheelchair suddenly moved towards street traffic,
- a laser beam went into the audience area of a light show,
- a radiation beam shutter did not close.

Electrically powered products can be sources of EMI, or unintentional receivers of electromagnetic fields, or both. The increasing use of electronics, proliferation of electromagnetic sources, and lack of electromagnetic compatibility (EMC) testing for many products has led CDRH to begin developing a strategy for EMC.

(Taken from "A Letter to Industry" *– an open letter from the FDA's CDRH (Center for Devices and Radiological Health) to registered medical device manufacturers, firms filing electronic product radiation reports, and related trade and professional associations, on September 18th 1996. The full text of this letter is at http://www.fda.gov/cdrh/emc/letter.html.)*

220) Radio waves can cause unintended movements of electric wheelchairs and scooters

This is to let you know that laboratory tests performed by the Food and Drug Administration (FDA) showed that radio waves can cause unintended motion of powered wheelchairs and motorized scooters. …. The following information summarises what you should know about EMI. You may use this information to minimize the risk that EMI will affect your powered wheelchair or motorized scooter.

…. If my wheelchair or motorized scooter is affected by EMI, what kind of motion should I expect? This is hard to predict. It would depend on an number of factors, including: the intensity of the radio waves, the construction of the powered wheelchair or motorized scooter, whether it is on level ground or on a slope, and whether it is in motion or still. The motion can be erratic, with the powered wheelchair or motorized scooter moving by itself or coming to a sudden stop. Further, it is possible for EMI to unexpectedly release the brakes on a powered wheelchair or cause it to go in unintended directions. Some intense sources of EMI can even damage the control system of the powered wheelchair or motorized scooter.

…. What can I do to reduce the risk that my powered wheelchair or motorized scooter could be affected by EMI? Here are some precautions that you can take:

1) Do not turn ON or use hand-held personal communication devices, such as citizens band (CB) radios and cellular phones, while the powered wheelchair or motorized scooter is ON.

2) Be aware of nearby transmitters, such as radio or TV stations and aware of hand-held or mobile two-way radios, and try to avoid coming close to them. For example, a powered wheelchair or motorized scooter with an immunity level of 20 V/m should stay at least three feet from a hand-held two-way radio and ten feet from a mobile two-way radio.

3) Be aware that adding accessories or components, or modifying the powered wheelchair or motorized scooter, may make it more susceptible to interference from radio wave sources. (Note, there is no easy way to evaluate their effect on the overall immunity of the powered wheelchair or motorized scooter.)

*(Taken from "*Radio waves may interfere with control of powered wheelchairs and motorized scooters*", published by the Department of Health and Human Services of the FDA on September 20, 1994. Available as a download from the FDA's website at http://www.fda.gov)*

221) Examples of interference from NASA

NASA Reference Publication 1374 (RP-1374), "Electronic Systems Failures and Anomalies Attributed to Electromagnetic Interference", can be downloaded in PDF format from the NASA Archive website at: http://trs.nis.nasa.gov/archive/00000296/01/rp1374.pdf.

Although it includes many case studies relating to the space program (some of which were very costly), it also includes cases from the marine, aircraft, automotive and medical industries. This publication is of great interest for electronics in general as it does not cover incidents relating to spacecraft charging from natural space plasma, which is of course peculiar to the space environment.

(From Władysław Moroń, Adviser to the President, Office of Telecommunications and Post Regulations, Republic of Poland.)

222) TV antenna boosters jam GPS over entire harbor and 1km out to sea

For months, the elusive culprit had jammed GPS signals in Moss Landing Harbor, Monterey California. The team of engineers roamed the waterfront with a spectrum analyser and receiver. They identified not one but two culprits, and unearthed evidence of a third, all of them readily available, commercial-grade television antenna boosters.

In April 2001 the captain of the research vessel PT SUR, based in Moss Landing, California, made a radio telephone call at-sea to one of the authors, stating that signal reception of GPS in the whole of Moss Landing Harbor was jammed. He was advised to contact the U.S. Coastguard (USCG) and the Federal Communication Commission (FCC). When the problem persisted for another month, we launched an effort at the local level to determine the cause of the jamming.

One of the major ships in the harbor paid for a technician and new equipment to fix the problem, but finally had to turn off GPS in the harbor area, give the alarm that GPS was off line, and use radar only for harbor entrances in bad weather.

We began our search for the source of jamming radiation in May 2001, spending several days looking for it. Two factors complicated the effort: the large number of metal objects that reflected the energy, and the shifting of the frequency of the emitter.

Only by turning off shore power to individual boats could we determine the actual emitter location. We contacted the boat owner and gained access, quickly determining that the emitter was a commercially available VHF/UHF television antenna with built-in preamplifier. The preamplifier was powered all the time, even when the TV was not on. In fact, the TV was seldom on, and most of the time the TV antenna was in a paint locker inside the locked boat. From this interior. Its emissions jammed all of Moss Landing Harbour and an area at least 1 kilometer out to sea.

A few days after Source-1 was removed, there were still long periods when our MBARI GPS receiver was tracking few or no satellites. The MBARI GPS receiver was being jammed during most nights. We conjectured that the jamming's diurnal pattern derived from the temperature sensitivity of the second jammer's center frequency. This turned out to be correct. This told us that we would have to search for the second jammer at night and early morning. Again the hunt was not easy. (*They abandoned the search for Source-2 and instead went hunting for yet another jammer they had discovered, Source-3.*) In the end, it turned out to be another commercially-available VHF/UHF television antenna on a boat, one dock over from Source-1.

The FCC has determined that the preamplifiers in Source-1 and Source-3 came from the same factory, which sold units to at least four well-known U.S. brand names of consumer electronics equipment. The bad units apparently began with a design change in late 2000; the number of units sold is not known to the authors.

The FCC made a few more attempts to locate Source-2 during the summer. In the fall of 2001, the FCC succeeded in locating Source-2. It again turned out to be a VHF/UHF television antenna with preamplifier.

Source-1 had the highest level at -96 dBm. Its location is known to have been 325 meters from the MBARI antenna. It was at an elevation angle of -2.5 degrees. While the beam pattern of Source-1 is unknown, if it were omni-directional, it would exceed the FAA specification for aircraft GPS receivers for GPS landing systems at a range of 50 kilometers or more. It is known to have caused marine GPS receivers to lose lock out to 3 kilometers.

Conclusion: In one small California harbor, at least three emitters capable of jamming commercial GPS receivers were present. Locating these sources proved difficult. The existence of the jamming was well-known in Moss Landing Harbor, and reported at least once to the appropriate agencies. However, the problem persisted until local engineers and scientists hunted down the worst offender.

(The above was extracted from "System Challenge – The Hunt for RFI – Unjamming a Coast Harbor" by James R Clynch, Andrew A Parker, Richard W Adler and Wilbut R Vincent of the Naval Postgraduate School, and Paul McGill and George Badger of the Monterey Bay Aquarium Research Institute, GPS World January 2003 edition, pages 16 - 22, www.gpsworld.com. Note how much time and effort it took to identify the low-cost culprits.)

223) Unreliability of GPS-based navigation systems

In July 2001, the Subcommittee on Safety of Navigation of the International Maritime Organisation (IMO) approved the draft revision of IMO Resolution A.815(19) World Wide Radionavigation system. Of particular interest in the Resolution is the requirement of signal availability of at least 99.8 percent over a 2-year period and continuity of service of at least 99.97 percent over a period of 3 hours for navigation on those harbor entrances, harbor approaches and coastal waters with a high volume of traffic and/or a significant degree of risk.

On most modern ships, (D)GPS is the only source of position information to the electronic chart (ECDIS) and to the mandatory onboard transponder of the Automatic Identification System (AIS). Especially on high-speed craft and on one-man bridges there is little time to cross-check navigation accuracy with other available information, such as radar. False position information to the AIS could even lead to "AIS-assisted collisions".

The Volpe report on GPS vulnerability recommends that public policy must ensure, primarily, that safety is maintained even in the event of loss of GPS. The reasons for possible loss of GPS are well described in the Volpe report and in other publications. However, IMO or other maritime bodies do not address solutions for the case of loss of GPS (yet). The future of the Northwest European Loran-C system is unsure after the end of the agreement between the participating countries in 2005; many world-wide maritime areas are not covered by Loran-C. Other terrestrial navigation systems for maritime application have been phased out. The combination of GPS and Galileo will increase the availability of signals and the possibility of Receiver Autonomous Monitoring (RAIM) but Galileo is also vulnerable to interference or jamming.

*(Extracted from the contribution by Jac Spaans, Professor Emeritus, President of the Netherlands Institute of Navigation, to the review entitled "*Directions 2003*" in GPS World, January 2003, pages 28 and 30, www.gpsworld.com. We note that GPS systems are cheap to implement because the U.S Military pays for the satellite system. No doubt this is why so many people want to use them, even for safety-related or safety-critical functions, despite their obvious shortcomings. The "Volpe" report can be downloaded via http://www.navcen.uscg.gov/gps/geninfo/pressrelease.htm or direct from http://www.navcen.uscg.gov/gps/geninfo/vulnerability_assess_2001.pdfThe reason why this item is included here, is that one of the main causes of unreliability in GPS is electromagnetic interference.)*

224) Jam GPS over radius of 100 miles, for just US$40

Electronic signal jamming devices that can be purchased through the Internet for less than $40 could play a decisive role in the effectiveness of possible U.S. air strikes against Iraq. According to recent report in the Wall Street Journal, U.S. congressional and military leaders are becoming increasingly concerned that widely available and relatively inexpensive devices that jam signals from GPS satellites could hamper efforts to effectively target high precision bombs in densely populated areas (such as Baghdad). Such munitions are now largely dependant on signals from GPS to deliver their warheads within 10 to 30 feet of their intended target.

Even the smallest of jamming devices can be remarkably effective at scrambling signals from GPS satellites. A 19 pound device demonstrated at the Paris Air Show in 1999 by a Russian company claimed effective jamming of GPS signals for more than 100 miles. The device boasted a puny 4 watts of power.

*(From "*GPS Jammers Could Hinder Attack on Iraq*", in the "Newsbreaks" section of Conformity, November 2002, page 8, www.conformity.com. The Wall Street Journal Article referred to in the above was "*US Bombs May Not Find Targets In Iraq Due to Satellite 'Jammers'*", Tuesday, September 24, 2002, www.wsj.com.)*

225) Baby alarm interferes with aircraft communications near some UK airports

A well-known make of wireless baby alarm is known to cause occasional interference with aircraft communication as the planes approach some airports in the UK. It is not the wireless technology in the baby alarm that is the problem, it is their plug-top power supply, which uses a switch-mode converter. A faulty batch of power supplies was shipped with the baby alarms, and although they function well enough they emit powerfully on VHF radio channels used by National Air Traffic Services Ltd. (NATS).

The interference is particularly difficult to detect on the ground but when NATS is informed of problems of this sort, they are able to overfly the troubled area with a specially equipped aircraft, partly funded by the Radiocommunications Agency (RA). When the aircraft has located the source of the interference, NATS will send in a specially equipped road vehicle which identifies the house concerned.

Officers from the RA then exchange the faulty plug-top power supply and send it back to the baby alarm manufacturer, who ship a (non-VHF-transmitting) replacement. It is a lot of trouble to go to for a low-cost electronic item, but flight safety requires us to do it.

(*From Tom Perry, UK Civil Aviation Authority (CAA), www.caa.co.uk.*)

226) Potential for xDSL to significantly raise the radio noise floor

Mass deployment of ADSL systems in Greater London has the potential to exceed the ITU noise floor. In addition, the emission level is predicted to exceed the maximum co-channel interference level of an airborne ADF (Automatic Direction Finding) receiver by up to 15 dB over the centre of the city, reducing to 2 dB at the edge of the city.

Mass deployment of VDSL systems has the potential to increase the noise floor by up to 18 dB at 10MHz at a height over central London of 100m. At the centre of London, the cumulative emissions level exceeds the ITU noise floor at all heights up to 20 km. At the edge of the city, an increase in the noise floor of between 5 dB – 8 dB is anticipated at a height of between 5 km – 10 km.

*(Extracts from: "*Prediction of interference due to telecommunication drop wires in the ADSL and VDSL bands*" by A R Bullivant or W S Atkins Singapore Pte Ltd and A J Maddocks, ERA Technology Ltd, presented by Tony Maddocks at the IEE Seminar "*EMC – It's nearly all about the cabling*" at Savoy Place, London, January 22nd 2003, www.theiet.org. ADSL and VDSL are the technologies used for delivering 'broadband internet access' over ordinary telephone wires.)*

227) GPS is vulnerable to jamming

The U.S. Department of Defense will use in-theatre jamming of the L1 signal to deny its adversaries the use of GPS. While jamming GPS signals has always been a military option, its use became a necessity following deactivation of Selective Availability. In addition to such military procedures, terrorists might try to jam the GPS signals using easily constructed equipment. GPS signals are also susceptible to unintentional jamming.

The civil GPS community got an eye-opener in 1997 as well. First, the Russian company Aviconversias announced in September that it could deliver a commercial GPS/GLONASS jammer capable of blocking civil GPS receivers within a radius of 200 kilometers. Then military GPS testing in the New York area in December caused a number of GPS receivers in civil aircraft to lose track of GPS signals during approach to Newark International Airport. Thus it was confirmed that civil receivers were vulnerable to jamming, and at the same time, that jamming equipment was commercially available.

One of the most important studies in this field, and – coincidentally – with very good timing (*released one day before the 9/11 attacks on the World Trade Centre – Editor*), was the so-called Volpe report on the vulnerability of GPS which concluded that, like other radionavigation systems, GPS is vulnerable to jamming, and that jamming of GPS could jeopardize safety and have serious environmental and economic consequences. The report also concluded that increased use of GPS in civil infrastructure makes it an increasingly attractive target for hostile activities by individuals, groups and states. At the same time, the analyses underlined the commercial availability of equipment for jamming purposes.

*(Extracts from "*Jamming GPS – Susceptibility of Some Civil GPS Receivers*", by Börje Forssell and Trond Birger Olsen, in GPSworld, January 2003, pages 54 - 58, www.gpsworld.com.)*

228) Reliability is important for GPS

In looking to the future, with GPS playing an increasingly important role in our daily lives, we must ensure that we maintain that reliability. With safety and security as its top priorities, the department has developed a 14-point action plan to mitigate any potential vulnerability. We are working closely with the Department of Defense in their GPS modernization efforts, redoubling our efforts to protect critical spectrum resources, and developing capabilities to locate sources of interference quickly.

*(An extract from an article by Jeffrey N. Shane, Associate Deputy Secretary, U.S. Department of Transportation, in "*Directions 2003*" in GPSworld, December 2002, Page 24, www.gpsworld.com. Forgive us for being critical, but it seems to us that the vulnerability of GPS is actual, not potential; and that sources of interference need to be located considerably more quickly than the several months reported in item 222. The reason why this item is included here, is that one of the main causes of unreliability in GPS is electromagnetic interference.)*

229) GPS signal reception will be more challenging in the future – example of UWB

The FCC published a rulemaking authorizing unlicensed ultra-wideband (UWB) signal emissions. Many believe these have the potential for interference to GPS and to raise the noise floor.

The GPS signal reception environment will be more challenging in the future – the UWB rulemaking is a bellwether event. There is incredible demand for wireless capability, which will only grow in the future. At the same time, dependence on GPS-based POITIME is increasing in military systems, in "safety-of-life" navigation systems, and in essential transportation, communications, financial, timing and other infrastructures.

*(Extracts from an article by Jim Doherty, Senior Analyst, Institute for Defense Analyses; member, Independent GPS Assessment Team, in "*Directions 2003*" in GPSworld, December 2002, page 26, www.gpsworld.com. Note that the GPS satellite signals are so weak that they are already below the ambient noise floor even in the quietest locations on the earth's surface. Software algorithms are used to make them readable. UWB is bound to be widely adopted because of its low cost.)*

230) GPS is so vulnerable to EMI that back-up systems are required for safety-of-life applications

The DOT/Volpe study on the vulnerability of GPS concluded that interference – either intentional or unintentional – could deny GPS access for critical infrastructure applications. It also concluded that, for safety-of-life applications, back-up systems to GPS would have to remain in place. Lacking other qualifiers in the summary text, one assumes that the back-ups are intended to remain in place indefinitely.

*(From an article by Terry McGurn, former senior analyst, Central Intelligence Agency, in "*Directions 2003*" in GPSworld, December 2002, page 33, www.gpsworld.com. The "Volpe" report can be downloaded via http://www.navcen.uscg.gov/gps/geninfo/pressrelease.htm or direct from http://www.navcen.uscg.gov/archive/2001/Oct/FinalReport-v4.6.pdf.)*

231) Vulnerability of GPS and Galileo and likelihood of jamming

The perception of the vulnerability of satellite navigation signals by both Europe and the United States seems to have changed 180 degree over the last ten years. In the 1990s, Europe was cautious about transitioning to GPS aviation landing systems, and it was Europe that pushed for the introduction of microwave landing systems (MLS) as a replacement for instrument landing systems (ILS). The key reason stated was the weakness of the signal delivered from space. The U.S. on the other hand, championed the benefits of GPS and declared that by the end of the 1990s, Wide Area Augmentation System (WAAS) and Local Area Augmentation System (LAAS) would be operational and ILS (and other navaids) a technology of the past.

Over the last year the U.S. has acknowledges that GPS is a vulnerable system, particularly to intentional and nonintentional interference, and has concluded that backup systems and techniques to find intentional interference will be required for critical infrastructure. On the other hand, Europe seems unworried by the situation and declares that Galileo (which will use the same technology as GPS) has a very good backup – called GPS.

Some also believe that the applications suggested for Galileo, such as road tolling, will promote widespread jamming by the public – with major implications for other users.

(Extracts from an article by Alan Shuster Bruce, Manager GNSS Programs, Thales Avionics UK, in GPSworld, December 2002, pages 33 and 34, www.gpsworld.com.)

232) Many common sources can interfere with GPS, and jammers are easy to make

Just recently, the U.S Coast Guard and FCC confirmed that certain consumer VHF/UHF marine television antennas cause inaccurate position information or a complete loss of GPS receiver acquisition and tracking ability. On a broader scale, the FAA has acknowledged interference sources to be commercial and civilian aviation such as broadcast television, personal electronic devices, Mobile Satellite Service (MSS) communications systems, and ultra-wideband (UWB) radar and communication systems. The busier the airwaves become, the more susceptible GPS is to interference.

With electronics schematics obtained from the internet, you can go to an electronics supply store, spend about $500 and get the parts you need to build a GPS jammer that can disable the commercial use of GPS out to 100 to 125 kilometers – line of sight.

One long-term solution would be to increase satellite signal power. But those large improvements are not scheduled for another 10 years! You can now use an appliqué or antenna and electronics add-on package which removes the interference before it gets to the GPS receiver. This is what ERI provides.

(Extracts from an 'advertorial' by Mario M. Casabona, President and CEO of Electro-Radiation Inc. (ERI), in "Showcase" in GPSworld December 2002, page 21, www.gspworld.com.)

233) Ensembles of sources will make interference problems harder to solve

ADSL and VDSL (broadband internet over ordinary telephone wires), low voltage lighting using 'transformerless' power supplies, plug-top switch-mode power supplies, variable-speed motor drives used in domestic appliances to save energy, power line telecommunications (PLT, also called PLC), ultra-wideband (UWB) radar and radiocommunications – are examples of the kinds of 'noisy' low-cost electronic devices and systems likely to enjoy wide adoption over the next few years.

If present trends continue (as they seem likely to) – in the not-so-distant future interference with radio communications (including safety-critical avionics systems) will no longer be identifiable or preventable as it will arise from 'ensembles' of many thousands of such cheap and cheerful interference sources, even if they all actually complied with the relevant emissions standards prevailing at the time they were taken into service and none are faulty (which is an unlikely situation in any case).

*(From "*Future Trends in EMC*" presented by Keith Armstrong of Cherry Clough Consultants at the Flomerics seminar "Introduction to EMC" in Taipei, Taiwan, September 17 - 18 2002, www.flomerics.com.)*

234) The EM environment is worsening whilst vulnerability to EMI is decreasing

The environment in which we live is becoming richer with man-made electromagnetic energy and at the same time the susceptibility threshold of electronic technology is decreasing.

(From Maqsood Mohd, Chairman of the IEEE EMC Society Education and Student Activities Committee (EASC), writing in the IEEE EMC Society Newsletter, January 2003, www.ewh.ieee.org/soc/emcs.)

235) Military base security upgrades interfere with car immobilisers and alarms

President Bush's son of star wars has neutralised its first targets in Yorkshire even before the British government has given the formal go-ahead for the RAF Fylingdales base on the moors to be used for the project. The upgrading of the security and surveillance systems at the base, in preparation for an onslaught of peace protesters objecting to the scheme, is knocking out the electrical systems of expensive cars.

Visitors to the beauty spot of Goathland, where the TV series Heartbeat is filmed to portray an idyllic 1960s rural life, have found themselves trapped among its charms. High power radar pulses trigger the immobilising devices of many makes of cars and motorcycles - BMW, Mercedes and Jeep among them. Many have had to be towed out of range of the base before they can be restarted.

The RAF admits it is a problem but says it is down to the car manufacturers to change their frequencies. However, Jeep claims this is not possible because of government restrictions.

Either way the locals are not amused. Frank Doyle, who owns a shop called Bazaar in Whitby, makes regular deliveries to the Goathland area in his Mercedes Vito van. He said: "I have got stuck three times in less than two weeks and have to keep calling breakdown services to get out of the place. "I am very fed up with it. It's not just the inconvenience - it messes up the business and my social life. Now when I'm on deliveries I keep the engine running, but still can't visit friends who live near Fylingdales."

Goathland resident Jackie Fearnley said: "I know that car alarms do go off, but this is getting ridiculous. It is disturbing all the villagers - and I don't think it is going to help tourism here either. Someone has got to sort this out."

North York Moors National Park car park attendant Bill Peirson said that Jeep Cherokees, Mercedes cars and vans, and BMWs seemed to be worst affected by the radar. "As soon as the alarms go off, I go over to the owners and explain it's probably the Fylingdales radar that's caused it.

"Motorbikes are the worst. There was a bike alarm screaming all afternoon recently and the rider didn't have any breakdown cover. I asked a friend in the village with a trailer to tow him away, and as soon as they were out of Fylingdales' range, it stopped."

Wing Commander Chris Knapman, of RAF Fylingdales, said it was not up to the base to resolve the problem. "We have had the frequencies we use for a very long time," he said. "They are allocated to commercial, military and government users, and the allocation is very tightly controlled. As far as we are concerned, the radars are working on frequencies which are well known, and most car manufacturers take that into account."

A spokesman for Jeep said: "The problem is that the government gives manufacturers such a narrow band to operate in - so the radio wave we use for our key fob is severely restricted."

*(From "*Son of star wars leaves drivers stranded*" by Paul Brown and Nigel Burnham, Wednesday December 18 2002, The Guardian Copyright, Guardian Newspapers Limited. Mike Feeney of Freeman Hospital, Newcastle on Tyne, spotted this on the Guardian Unlimited site. To see this story with its related links, go to http://www.guardian.co.uk.)*

236) TV antenna boosters interfere with specialised mobile radio systems

These devices *(active television antenna profiled in January 2003 GPS World article)* can also interfere with specialized mobile radio (SMR) systems. We have a cell site near Mission Bay in San Diego. A few months ago we started getting interference on several of the channels in this site. The interference was centred around 815MHz and was about 2MHz wide.

Two days of sniffing it out with a spectrum analyzer was required. The boat owner was on an extended trip but allowed us to disconnect the offending antenna.

(Rich Reinhofer, Supervisor RF Operations, Nextel, San Diego, writing in GPS World, March 2003, page 8, www.gpsworld.com. The article he is referring to was summarised in Banana Skins No. 222.)

237) TV antenna boosters interfere with cell phone systems

I've also been involved in hunting down interference caused by active television antennas. In my case, the interference was to a cellular telephone system and the TV antennas were mounted atop RVs *(Recreational Vehicles – Editor)* at mobile home parks. The unit(s) causing interference were in some cases more than two miles from the cellular phone site that was receiving interference.

If what you were tracking *(see Banana Skin 222 – Editor)* was the second harmonic of the signal from the oscillating amplifier, the signal only has to drift a small amount for the fundamental signal to cause interference to the base station receivers of cellular telephone, public safety, and business radio systems operating in the 806-849 MHz band.

IS-95 CDMA cellular telephone systems are extremely sensitive to this type of interference. In my company's case, finding the offending devices and getting them turned off is worth a nearly unlimited effort.

Author's reply: The emissions from the antenna we studied in detail had a fundamental frequency near 1575 MHz. This was not a harmonic. Its precise frequency depended upon temperature and other environmental variables. The other two antennas also had temperature-dependant frequencies near to the GPS L1 frequency, but we did not study them in a laboratory environment. We do not know that this was the fundamental frequency for the other two RFI sources, but that is likely. *Jim Clynch*

(Eric Lawson, Senior Engineer, Alltel Communications, writing in GPS World, March 2003, with reply, Page 8, www.gpsworld.com. Note that in the USA all the personal cellphones operate around 1.9GHz, but they have a number of other specialised cell-based telecommunication networks operating in the 800-850 MHz region, including a country-wide system for use by police and other emergency services, see Banana Skin No 179.)

238) TV antenna boosters causing interference to GPS etc. identified by US Coast Guard

We are currently *looking* at numerous applications for GPS on board locomotives. I was quite interested in the recent article "The Hunt for RFI" but was quite disappointed that it did not list the model or manufacturer's name of the offending pre-amplifiers as we may want to put out a bulletin to determine if any of these devices are installed in our railroad yards or office cars. Is this information available? *(Gary G Wilson, RF Systems Engineer)*

I have been involved with tracking similar problems with interference to radio systems here in Indianapolis, Indiana area. The cause of the interference has been traced to defective manufactured RV television antennas. The article did not mention the manufacturer of the antenna. Could you pass along my query about the manufacturer? *(Bill Atkin)*

Names of the equipment jamming GPS were not published in the January article for liability reasons. The U.S. Coast Guard now has a safety notice at www.uscg.mil/hq/gm/moa/docs/11-02.htm, listing brands and model numbers of known emitters. You can reach this site via www.navcen.uscg.gov by going to GPS, Notes, and Information. The list may not be complete, however. The model traced by Bill Atkin is not on it. The FCC tracked the preamplifiers in three jamming antennas to an overseas factory owned by a subsidiary of a U.S. company. It is believed that the bad units began with a design change in late 2000. The number of units sold is not known, but they went to at least five different companies producing consumer goods.

(*Two letters published in GPS World, March 2003, page 8, with a reply from that publication's editor, www.gpsworld.com. See Banana Skin 222 for the article that began this correspondence. Another site for the US Coast Guard report used to be: www.ccg-gcc.gc.ca/mcts-sctm/GPSinterference-e.doc.)*

239) Complying with immunity standards might not defend against product liability lawsuits

The following *jurisprudence* shows how negligence can be interpreted. In the Netherlands a recent lawsuit came up about a wheelchair. This chair unintentionally drove off a subway-platform. The driver was badly injured and her insurance company started an investigation with help of an EMC laboratory. They found out that the chair was activated by a field of only a few Volts/meter at a frequency of 1.89 GHz.

The manufacturer of the chair did not accept his responsibility by arguing that his chair did meet the relevant product standard for wheelchairs. The radiated susceptibility test in this standard however did not go beyond 1 GHz. The judge decided that the manufacturer could have known that 1.89 GHz was a commonly applied frequency for the digital telephone network.

The manufacturer was sentenced because he had put an unsafe product on the market. It should be noted that this example is about Product Liability and not about EMC. We also learn from this case that the application of a standard is not a guarantee for being safeguarded from lawsuits.

*(From Dick Groot Boerle, Teamleader EMC Laboratory for Thales Nederland B.V., from his paper "*EMC and Functional Safety, Impact of IEC 61000-1-2*", the IEEE International EMC Symposium, Minneapolis, August 2002.)*

240) HMS Sheffield disaster caused by lack of EMC

Electromagnetic effects can cause impressive disasters that urge us to control the problem. One example is the catastrophe with H.M.S. Sheffield during the Falkland crisis. An Exocet missile hit this frigate because its search radar was switched *off (preventing its anti-missile weapons from being used – Editor)* It was switched off because it was known that the satellite communication system was interfered with by this radar.

At the time of the disaster some officers used this communication link to talk with their prime minister…..The 'disaster philosophy' is already known to many EMC-engineers who every now and then make use of a disaster to get new budgets.

*(From Dick Groot Boerle, Teamleader EMC Laboratory for Thales Nederland B.V., from his paper "*EMC and Functional Safety, Impact of IEC 61000-1-2*", the IEEE International EMC Symposium, Minneapolis, August 2002.)*

241) X-band radar interfered with ship steering in Rotterdam

The case in the Rotterdam harbour is an 'old case' of about 15 years ago: we have installed X-band (1 kW) radars for Vessel Traffic Control and due to one of these transmitters the steering machine of a small towing ship was influenced in such a way that the ship hit the quay.

(From Dick Groot Boerle, private correspondence with Editor, June 2002.)

242) Intense DC magnetic fields from superconducting magnets

In the late 1960s and *early* 1970s the International Research and Development Company Ltd (IRD) of Newcastle upon Tyne were engaged in the building of prototype superconducting DC machines. These were of the homopolar type, in which a conducting disc armature with brushes near the shaft and at the perimeter rotates in the axial field with a maximum field strength of several Tesla produced by a large superconducting coil.

The field coil had to be cooled to 4.2 degrees Kelvin and one of the most difficult aspects of the design was to minimise heat conduction to the coil via the current leads. The solution was to weld a long tube to the top of the cryostat through which long current leads were taken and to suspend the coil from the top of the tube by means of thin high tensile wires in a bifilar suspension. The coil was in essence freely hanging. Now in a normal DC machine there will be a torque reaction on the field winding structure when delivering power, but a feature of the disc type homopolar machine is that the conductors feeding current to and from the armature brushes take the reaction and not the field coil.

Thus it was that the 50 HP prototype with its freely suspended field coil was tested in the laboratory satisfactorily. IRD then scaled up the 50 HP motor to a 3.25 MW boiler feedpump motor that, after much tribulation, was finally installed at Fawley Power Station. The great moment came when the refrigeration systems were finally working and after about a week the coil resistance had reached zero. The field power supply was gradually switched on and then suddenly there was an almighty clunk as the massive field coil in its wrapping of mylar superinsulation banged against the cryostat walls. This was not supposed to happen and the structure was not designed for this eventuality!

What everyone had forgotten was that there would be massive amounts of steel in a power station and it was to this steel that the energised coil was attracted. Much time was then spent positioning additional steel masses in appropriate positions around the power station to neutralise the attractive forces. These masses had to be strongly bolted down, otherwise they would have taken off and crashed into the cryostat.

(From Dr Antony Anderson, private correspondence with Editor, 25 Oct 03,www.antony-anderson.com.)

243) Wireless keyboards crosstalk

Two Norwegian computer users have found that wireless keyboards may be a security risk, after they accidentally transmitted their typed words to each other's computers 150 metres away.

("60 Seconds Technology", page 6 of New Scientist 16 Nov 2002, www.newscientist.com.)

244) Pros and Cons of using wireless information technology in hospitals

Since the 1960s, there have been reports [1] that electromagnetic interference (EMI) can cause critical-care medical devices to malfunction. Such malfunctions have caused inappropriate therapy, patient injury, mortality, or have had the potential to do so. Fortunately, such incidents are rare, and the incidence of such malfunctions appears to be declining with time. However, vigilance is still required because (1) the electromagnetic compatibility (EMC) of many new radio-frequency (RF) sources and new medical devices being introduced into healthcare is unknown, and (2) there will be a substantial increase in usage of wireless information technology needed by healthcare but the EMC of such technology is unknown.

The latter need has been highlighted by reports that perhaps 1 out of every 200 patients admitted to US hospitals die due to medical errors, an annual rate exceeding that due to automobile accidents or due to heart disease. In the vast majority of cases, excellent physicians and medical staff make such errors because they do not have access to appropriate information (e.g., medication errors; current information unavailable). At least some of these deaths would be preventable if wireless information technology were widely used. However, the associated increased RF emissions may cause increased medical-device malfunctions.

(*Taken from: "*Risk of patient injury due to electromagnetic interference malfunctions: Estimation and minimization*" by B.Segal et al, IEEE International EMC Symposium, Montreal, August 13-17 2001, page 1308 in the Symposium Record.*)

245) Interference potential in hospitals requires comprehensive EMI strategies

Whilst the number of EMI-related incidents documented during the 1990s was quite small, government statistics do establish that patient morbidity and mortality did result from the ensuing electromagnetic interference from EMES (electromagnetic energy sources) and medical devices, including medical device to medical device interference.

It is submitted that the new millennium will pose greater EMI challenges for healthcare professionals due to two emerging phenomena. The first is the integration of wireless technology into many medical devices for monitoring control and intercommunication purposes. Thus with the addition of digital and wireless technologies, many therapeutic devices will have tripartite functionality. The second important phenomenon will be the integration of wireless technology into the physical infrastructure of hospitals (smart building concepts) for monitoring, control, tracking, record-keeping and intercommunication (of equipment and personnel purposes).

At present, a small number of hospitals are integrating the operation of the cellular telephones of their healthcare staff into the hospital PBX system, but 'digital hospitals' concepts are emerging which will integrate which will integrate fully both wireline and wireless communications into the physical infrastructure of the healthcare facility. Obviously, these phenomena have the potential to increase the ambient level of electromagnetic energy within hospitals and they call for comprehensive EMI strategies.

(*Taken from: "*Risk analysis and EMI Risk Abatement Strategies for Hospitals: Scientific and Legal Approaches*" by David A Townsend, Faculty of Law, University of New Brunswick, Canada, IEEE International EMC Symposium, Montreal, August 132-17 2001, page 1304 in the Symposium Record.)*

246) FDA records over 500 incidents of interference with cardiac pacemakers

FDA has evaluated reports of medical device malfunctions caused by electromagnetic interference (EMI), performed device testing, and developed standardized test procedures. Over 500 incident reports are suspected to be attributable to EMI affecting cardiac pacemakers. More than 80 of these reports involve cardiac and other medical device interactions with electronic security systems.

EMI presents a risk to patient safety and medical device effectiveness that is likely to continue as the use of electromagnetic energy in the medical device environment increases (e.g. cell phones, security systems).

(*Taken from: "*Medical Device EMI: FDA Analysis of Incident Reports, and Recent Concerns for Security Systems and Wireless Medical Telemetry*" by Donald Witters et al, of the Center for Devices and Radiological Health (CDRH), Food and Drug Administration (FDA) Rockville, USA, IEEE International EMC Symposium, Montreal, August 13-17 2001, page 1289 in the Symposium Record.)*

247) Experiences of interference with medical devices in Canada

Electromagnetic interference (EMI) has been responsible for many medical device malfunctions, raising concerns about the safety of patients who depend on these devices. However, the incidence of unreported EMI malfunctions is unknown. Between 1984 and 2000, Health Canada's Medical Devices Bureau received thirty-six reports of medical device malfunction attributed to EMI. These included 4 reports of medical device malfunctions caused by wireless cellular phones, two cases of EMI interference from electronic article surveillance (EAS) systems on implantable cardiac pacemakers and possibly one case of premature failure of a pacemaker.

The Bureau also investigated reports of interference from other radiofrequency sources. These included (1) Interference of an electrosurgical device with the electrocardiogram signals displayed on the monitor of an automated defibrillator; (2) Complete inhibition of the pacing signal of a pacemaker by a pulsating magnetic field from a video display terminal; (3) Failure of the R-wave detection circuitry of a cardiac defibrillator in the presence of a simulated muscle artifact signal from an electrocardiogram simulator; and (4) Interference of the line isolation system in an intensive care unit with the performance of a defibrillator. These reports highlighted the need for guidelines on the management of EMI within hospitals, especially in critical-care areas.

(T*aken from: "*Electromagnetic Interference in Medical Devices: Health Canada's Past and Current Perspectives and Activities*" by Kok-Swang Tan et al, Medical Devices Bureau, Therapeutic Products Directorate, Health Canada, IEEE International EMC Symposium, Montreal, August 13-17 2001, page 1283 in the Symposium Record.)*

248) Electrosurgical equipment interferes with endoscope video monitor during operation

The problem — electromagnetic interference (EMI) from electrosurgery units transmitting noise onto real-time video images from an endoscope being used during the operation.

(*Taken from: "*Electromagnetic Interference (EMI) in an Operating Theatre Environment*", Nigel Beaumont-Rydings, Royal Oldham Hospital, meeting of the "CE North West" club, 30th March 1998.*)

249) Some experiences with interference to medical devices

Steve Juett provided the first "War Story" on the EMC challenges facing biomedical instrumentation in hospitals. He presented very straightforward slides illustrating the situation. The FDA has no immunity requirements for biomedical instrumentation. Not surprisingly, the myriad of telemetry links and proliferation of personal computing devices and cellphones present challenges to medical equipment used to save lives, the sensitivities of which can be in microvolts!

Finally, Steve Juett provided another story from the biomedical arena – tracing down the source of an interference problem at the hospital to a local TV station trying out its HDTV band. It took some effort to get in touch with the right individual at the TV station to resolve the problem!

(*Taken from a report on the May 2001 meeting of the IEEE EMC Society Dallas USA Chapter, in the IEEE EMC Society Newsletter Issue 92, pages 8-9. Steve Juett is the Director of Biomedical Engineering at Baylor Hospital in Dallas.*)

250) Cellphone basestation interferes with hospital

I do a lot of work with shielding for MRI scanners. RF interference can ruin the images, which are time-consuming and expensive so all MRI scanners are installed in rooms with some degree of shielding.

One hospital I visited to trace an interference problem was the quickest job I ever had. The hospital had "Switch off your cellphone" warning signs all over it – and a plainly visible cellphone basestation on its roof. When they got the basestation switched off, their interference problems ceased.

(*Gary Fenical of Laird Technologies, www.lairdtech.com, private conversation with Editor, 23rd May 2002.*)

251) More examples of interference with medical devices

A number of medical interference incidents listed in The "1998 EMC Encyclopaedia" from Emf-Emi Control, Inc…..

- Apnoea monitors susceptible to FM transmissions: The US FDA has reported cases where susceptible apnoea monitors used to monitor the breathing of newborns during sleep have been affected by EMI from RF broadcast sources. The apnoea monitor is designed to alarm when the newborn stop breathing. External interference has been demonstrated to mimic the rhythmic breathing patterns when the interference modulation is demodulated by an audio rectification mechanism. The effect is to fool the apnoea monitor and not alarm properly.

- Patient monitoring system picked up EMI causing alarms not to sound. Two patients died when system failed to detect arrhythmia.
- Paramedics could not sense heart rhythm due to excessive artifacts on CRT monitor. Patient not resuscitated.
- External defibrillator/pacemaker stopped pacing when ambulance attendant used hand-held transmitter too close to patient.
- Battery charger cycling at 1-Hz rate in respiration monitor, coupled to respiration circuit. Patient died with no alarm.
- Intro-Aortic balloon pump stopped pumping when system printer was turned on.
- Pacemaker ceased function during ambulance radio transmission.
- Ventilator - cessation of ventilation, inoperative monitoring, error messages.
- ESD Disabled apnoea monitors without activating an alarm.
- Radiation therapy device - ESD caused source to turn on, display to blank, unintended gantry movement, timer failures.
- Severe interference with heart rate and graphs of ICU patient monitor when blood-pressure monitor in use.
- Infusion pump caused interference with patient monitors.
- Movement of chiropractic table caused by muscle stimulator.
- Microsurgical drill began to run when electrosurgery unit was activated.
- Erroneous displays and latch-up of anaesthesia gas monitor during electrosurgery.
- Intro-Aortic balloon pump stopped pumping when system printer was turned on.
- Neonatal monitors were interfered with when placed close to similar models.
- Respiration rate controller ceased to function when oxygen analyzer was placed on top.
- Cellular phones interfered with incubators, infusion pumps, dialysis equipment, defibrillators. They are banned from some hospitals in Europe.
- Reading of invasive blood pressure monitors jumped 3 to 10 mm Hg when paging transmitter on hospital roof was activated.
- Displays of telemetry patient monitor would “flat-line” when paging company transmitted digital control information to remote sites.
- ECG monitor in defibrillator was interfered with when emergency crew transmitted with antenna inside station wagon with defibrillator.
- Pulse oximeter displayed saturation of 100% and pulse rate of 60 on a patient who had expired. Telemetry transceiver, part of the system, too close to oximeter.

252) Guidance on use of wireless handsets in hospitals

TETRA: The risk to medical devices from the use of TETRA handsets is comparable to that from GSM cellular phones. All personnel using TETRA handsets on hospital premises should therefore be made aware of, and follow, the local policy guidelines applicable for cellular phone systems. In the case of emergency services dealing with an on site incident, the risk of interference should be treated as secondary to the risks associated with managing the incident. Staff responsible for Trust radio communication policy should liase with local representatives of the emergency services to agree and formulate local working practices.

Outside Media Broadcasts: Ensure that a hospital representative such as the Risk, Safety Communications Manager is available to assist Media personnel with the location and operation of equipment. Media personnel using radio handsets (radio-talkback system) on hospital premises should be made aware of the hospital policy on use two-way radios for all locations in which they will be working. Ensure that any outside broadcast vehicles equipped with radio-talkback and microwave link transmitters are parked as far away as practicable from patient treatment areas or wards.

(*Extracted from Medical Devices Agency Safety Notice SN 2001 (06) downloaded from www.medical-devices.gov.uk on January 2nd 2003. The full notice gives information on the technical basis for these warnings.*)

253) Ninety reports of medical device malfunctions due to security equipment 1998-2001

The Food and Drug Administration (FDA) received over 90 problem reports of medical device malfunctions related to EMI from magnetic field emitting security devices since 1998. The malfunctions were judged serious enough by the reporters (clinical users of these devices) to potentially cause patient injuries. Examples of malfunctions with implanted devices ranged from disturbances in the cardiac sensing operation of pacemakers, unintended firing of implanted cardiac defibrillators (ICDs), changes in drug delivery rates of infusion pumps, and over-stimulation of patients with neurostimulators resulting in severe pain or falls.

As a result, the FDA undertook a study of the EM fields emitted from the security screening systems to determine the nature of the EM fields seen by electronic medical devices worn by, or implanted in, patients passing near these screening systems. Measurements of the magnetic field emissions from security devices reveal that some security screening devices can emit fields at strengths that exceed the test level specified in some medical device standards. The FDA took action to alert users and manufacturers of active medical devices and security screening devices of the potential for interactions.

(*Taken from: "*Comparison of Magnetic Fields Emitted from Security Screening Devices with Magnetic Field Immunity Standards*" by Jon P Casamento of the FDA's Centre for Devices and Radiological Health (CDRH), presented at the IEEE 2002 International EMC Symposium, Minneapolis, August 19-23, pages 937-940 in the Symposium Record.*)

(*Editor's note: the standards referred to in Jon's paper were CENELEC draft standards prEN 45502, Part 2-1 for cardiac pacemakers and Part 2-2 for implantable defibrillators. The 2002 version of EN 60601-1-2 (the EMC safety standard for medical devices) includes a magnetic field immunity test of 3A/m but only at 50Hz, whereas the security screening devices he tested could emit fields of up to 1000A/m at frequencies between 200Hz and 100kHz and 3A/m up to 10MHz.*)

254) Medical diathermy as a source of electromagnetic interference

Medical diathermy is used for physiotherapy, to heat tissues throughout their volume. 27MHz continuous 'short-wave' diathermy can use RF powers of up to 400W, but is becoming unfashionable. 27MHz pulsed short-wave diathermy is just coming into fashion and uses average RF powers of around 40W. 2.45GHz microwave diathermy is out of fashion, people being scared off by the idea of 'microwave cooking'. There is also a technique known as Interferential Therapy which operates at 4kHz.

Electrosurgery equipment typically uses 500kHz. 'Cutting' typically uses 1200V and 400W, 'Point Coagulation' typically uses 2000V and 150W, 'Spray Coagulation' uses 380V and 80W, and 'Blend' uses 1800V and 300W (*the high frequency prevents the patient from receiving a fatal shock - Editor*).

There are significant levels of emissions from the diathermy and electrosurgery leads, and most theatre equipment is now designed to avoid interference from this source. 'Bipolar' diathermy technology reduces the interference caused; and most modern equipment uses sinusoids, which reduces the potential of harmonic emissions to cause interference problems.

A traction machine in a physiotherapy department has been seen to malfunction when a 27MHz diathermy system was switched on in the next room. The long leads associated with pacemakers make good antennas and can download large currents at 27MHz directly into the heart, damaging it. External pacemakers used during surgical operations have much longer leads than implanted pacemakers, and are a nightmare. Diathermy has also caused certain defibrillators to charge up and some pulse oximeters to give wrong readings.

*(Taken from: "*Surveying a hospital for electromagnetic interference*" by Lindsay Grant, Consultant Clinical Engineer, Royal United Hospital, Bath, U.K., IPEM conference "*Practical Methods for Mitigation of EMI and EMF Hazards within Hospitals*", York, 28th January 2003. IPEM is the Institute of Physics and Engineering in Medicine, at: http://www.ipem.org.uk. Diathermy and electrosurgery are well-known by surgeons as causes of interference problems. For more examples see Banana Skins 83, 247, 248, 251, 257, 258 and 261.)*

255) Medical device interference from mobile phones

Actual reports of serious problems are hard to come by. However, in-house tests at the University of York, and field-test studies such as that commissioned by the Medical Devices Agency have shown that many types of hospital equipment are susceptible to RF radiation, although generally only at distances of less than 2m. Victims of EMI from mobile transmitters typically include diagnostic equipment such as ECGs, EEGs, pulse oximeters and other physiological monitoring equipment; plus therapeutic equipment such as infusion pumps, ventilators and defibrillators. Physiological monitoring has a bandwidth of around 100Hz and is very sensitive – so very susceptible. For example the sensitivity of an ECG is 1mV and of an EEG is 100μV, whereas 'Evoked potential' monitors can be sensitive to as low as 1μV.

The type of modulation employed by the mobile transmitter can be significant. For example, an external pacemaker we tested withstood a GSM modulated signal at 30V/m field strength, but TETRA modulation caused interference at 3V/m. GSM modulates its signal at 217Hz, whereas TETRA uses 17Hz which has a greater probability of lying within the pass-band of medical equipment.

We found that a distance of 1.2 metres was required for the medical equipment we tested to be safe. For comparison: Rice and Smith (Canada) found that 10 out of 14 devices failed with a 0.6W mobile phone at distances of under 500mm; Irnich and Tobisch (Germany) tested 224 devices and recommended a safe distance of at least 1 metre; The U.K.'s Medical Devices Agency tested 178 devices and found that 4% exhibited effects with mobile transmitters at 1 metre, although only 0.1% of them had serious effects at that distance (Bulletin BD 9702).

*(Taken from "*Mobile communication systems and medical equipment*", by M P Robinson, I D Flintoff and A C Marvin, York Electromagnetics, University of York, IPEM conference "*Practical Methods for Mitigation of EMI and EMF Hazards within Hospitals*", York, 28th January 2003. IPEM is the Institute of Physics and Engineering in Medicine, at: http://www.ipem.org.uk.)*

*(Also see: M P Robinson, I D Flintoft and A C Marvin, '*Interference to medical equipment from mobile phones*', J. Med. Eng. Technol. vol. 21, p. 141, 1997. M L Rice and J M Smith, '*Study of electromagnetic interference between portable cellular phones and medical equipment*', Proc. Canadian Med. Biol. Eng. Conf. p330, 1993. Steve Smye, '*Assessing the risk to medical equipment of interference from mobile phones*', EMC York '98 Conf. Proc., July 1998, "*Electromagnetic compatibility of medical devices with mobile communications*", Bulletin MDA DB 9702 March 1997 from the U.K. Medical Devices Agency, http://www.medical-devices.gov.uk, "*Safety Notice SN 2001 (06)*", the U.K. Medical Devices Agency, www.medical-devices.gov.uk.)*

256) MRI scanners as a source of electromagnetic problems

Magnetic Resonance Imaging (MRI) uses very powerful static magnetic fields, up to 3 Tesla in the U.K., but systems with up to 8 Tesla are available and there is a trend towards using more powerful fields. This magnetic field can accelerate ferromagnetic objects with serious consequences. A patient was struck by an oxygen bottle while being placed in the magnet bore. Parts of a fork lift truck weighing 800 pounds were accelerated by the magnet, striking a technician and resulting in serious injury. A pair of scissors was pulled out of a nurse's hand as she entered the magnet room, hit a patient, causing a head wound. Dislodgement of an iron filing in a patient's eye during an MRI exam resulted in vision loss in that eye.

Implantable medial devices such as stents, clips, prostheses, pacemakers and neuro-stimulators are all potential hazards in an MRI scan, and devices should be tested for MR compatibility. It is known that pacemakers can be very sensitive to static magnetic fields of the order of 1 milliTesla. Monitoring equipment such as ECG, heart-rate, blood pressure, blood oxygen monitors are also of concern. MRI scanners also use intense RF fields, with most U.K. systems operating at 42.6, 63.9 or 127.8MHz.

*(Taken from: "*Electromagnetic fields in the hospital environment*", by Jeff W. Hand, Director, Radiological Sciences Unit, Hammersmith Hospitals NHS Trust, London, IPEM conference "*Practical Methods for Mitigation of EMI and EMF Hazards within Hospitals*", York, 28th January 2003. IPEM is the Institute of Physics and Engineering in Medicine, at: http://www.ipem.org.uk.)*

257) The hospital EM environment often exceeds IEC immunity standards for medical devices

E-M fields in hospitals. Broadband RF field measurements in the hospital environment have found that E fields can be up to 30V/m. The strongest sources included electrosurgical units, hand-held radios and VDUs. Power frequency magnetic field measurements in the hospital environment have found H fields up to 5A/m.

The strongest sources included power lines and supplies, patient monitoring equipment, VDUs and electrosurgical units. 63% of all E-field measurements and 7% of all H-field measurements made in the hospital environment exceeded proposed IEC immunity requirements for medical devices.

*(Also taken from: "*Electromagnetic fields in the hospital environment*", by Jeff W. Hand, Director, Radiological Sciences Unit, Hammersmith Hospitals NHS Trust, London, IPEM conference "*Practical Methods for Mitigation of EMI and EMF Hazards within Hospitals*", York, 28th January 2003. IPEM is the Institute of Physics and Engineering in Medicine, at: http://www.ipem.org.uk.)*

258) Immunity issues with pacemakers

Pacemakers have always been designed with interference in mind. When they sense signals outside of the normal signal range of 10 to 300 beats per minute they go into an 'interference mode' and pace in a backup safety mode. This will keep the patient alive but will make them feel very unwell. All modern pacemakers have bi-directional radio telemetry systems that allow the cardiology technician to send instructions to the pacemaker. The digital coding is robust, but it is an obvious point of entry for interference signals.

In general mains signals do not cause problems with pacemakers. Surgical diathermy can be a problem. There have been some reports of pacemakers being damaged and some currents being conducted down the lead and causing myocardial tissue fibrosis, with consequent loss of pacing function, but these are extremely rare. Arc welding has long been known to be contraindicated for patients who have pacemakers. The problem is mainly with spot welding as the interference generated can appear at roughly cardiac frequencies. There have been isolated reported cases of ventricular standstill when a therapeutic ultrasound unit's lithtripter is synchronised to the P wave of the ECG. RF physiotherapy equipment using pulsed and CW at 27MHz can cause interference problems – care needs to be taken and an expert involved in any discussion about patient treatment.

GSM mobile phones can be a problem when held very close to the pacemaker site. This is due to the 2.2Hz bursts of 900MHz signal at switch on and switch off, and 8.3Hz bursts during the ring phase. Patients are told to use the phone with the ear opposite the pacemaker site and not to keep it in their breast pocket. Otherwise there are no problems. Transcutaneous nerve stimulators (TENS) *(such as are used in slimming and muscle toning devices – Editor)*, are common sources of interference. They can cause complete inhibition of pacing and potential death. Patients who require TENS above the waist should be individually evaluated by the pacemaker clinic and safe levels of operation established.

A number of recent reports have indicated that Electronic Article Surveillance (EAS) systems in shops can be a problem. These normally only occur when pacemaker patients linger close to the security gates. Under some extreme circumstances the field can be sufficient to cause the pacemaker to revert to its emergency reset conditions. This is not life-threatening but can make the patient feel very unwell.

External pacemakers are particularly prone to interference because they have a much longer lead and the system is not entirely screened within the body Such systems carry a high risk in the hospital environment and patients need to be kept well away from physiotherapy departments which have potentially life threatening sources of interference. Mobile phones and hospital radios can also cause problems that may initiate dangerous cardiac arrhythmias.

*(Taken from "*Electromagnetic interference and cardiac pacemakers*", by Lindsay Grant, Medical Physics Department, Royal United Hospital, Bath, IPEM conference "*Practical Methods for Mitigation of EMI and EMF Hazards within Hospitals*", York, 28th January 2003. IPEM is the Institute of Physics and Engineering in Medicine, at: http://www.ipem.org.uk.)*

259) Most medical devices fail EMC tests at first attempt

It is quite staggering to discover that over 90% of medical electrical devices that we have tested have failed to comply with the standards applied for on the first attempt.

*(Taken from: "*Why 90% of medical devices fail conformity assessment the first time around*", by Donald J. Sherratt,* Medical *Stream Director, Intertek Testing Services, IEEE 2002 International EMC Symposium, Minneapolis August 19-23 2002, Workshops and Tutorial Sessions. Note that his graphs show 97% failing EMC tests to IEC 60601-1-2:1993 – which is easier to meet than the current versions of the generics – and 90% failing safety standards.)*

260 EMC efforts are needed to save lives with wireless informatics in hospitals

Healthcare need wireless informatics to reduce the numbers of patients dying from medical errors (such as lack of patient medical records). The electromagnetic environment in a hospital is very low, if no portable radio-frequency sources are near by. *(But see Banana Skin No. 257 – Editor.)*

But the EMI patient-injury risk is hard to calculate because the immunity of medical devices is largely unknown. The potential for EMI malfunction is very high, but these don't necessarily injure patients. Even though the patient-injury risk is small, it needs minimisation. Soon, wireless usage in top hospitals will not be optional, it will be essential. EMC efforts are needed to make it happen.

*(Taken from "*Wireless Informatics in Healthcare: Making it work*" by Bernard Segal, McGill University, SMBD Jewish Hospital, Montreal, speaking in the "Current EMC issues in healthcare" workshop session of the IEEE 2002 International EMC Symposium, Minneapolis, August 19-23 2002.)*

261) Under-reporting of medical EMI incidents considered likely

In the USA, the Food and Drug Administration (FDA) collects reports of medical equipment failure. Jeffrey Silberberg of the FDA's Centre for Devices and Radiological Health (CDRH) states that between 1979 and 1993 there were over 100 reports attributed to EMI. These include interference to a wide range of devices, including ECG, ventilators, infusion pumps and apnoea monitors, from a variety of sources including electrosurgery, fluorescent lights and radio transmitters.

The EMI reports form only a small portion of the 95,000 incidents reported to the FDA each year, but Silberberg and others believe there is widespread under-reporting of EMI incidents.

*(Taken from "*EMC of Medical Equipment*", Dr Martin P Robinson, University of York, N. J. Wainwright York EMC Services Ltd., EMV'99 Dusseldorf, Germany. Also, see – "*Performance degradation of electronic medical devices due to electromagnetic interference*", Jeffrey L Silberberg, Compliance Engineering vol. 10 p. 25 1993. An updated version was published in Compliance Engineering's European Edition's 1995 Annual Reference Guide as: "Electronic medical devices and EMI", pages F-10 - F-15, www.ce-mag.com.)*

*Editor's note: Other useful sources of information on medical EMC issues include the IPEM seminar mentioned in Banana Skin numbers 254-258, plus: "*Electromagnetic compatibility for medical devices: Issues and solutions*", FDA/AAMI Conference 1995, conference report edited by Stephen Sykes of the U.S. Food and Drug Administration, 1996, ISBN 1-57020-054-8; "*Electromagnetic compatibility / electromagnetic interference: Solutions for medical devices*", FDA/AAMI Conference 1997; "*Technical Information Report TIR-18 – 1997: Guidance on electromagnetic compatibility of medical devices for clinical/biomedical engineers – Part 1: Radiated radio-frequency electromagnetic energy*" – all published by the Association for the Advancement of Medical Instrumentation, http://www.aami.org.*

For FDA's Centre for Devices and Radiological Health (CDRH) "Safety Alerts", public health Advisories and Notices, go to: www.fda.gov/cdrh/safety.html. For the FDA's "Med Watch" safety information and adverse event reporting program, go to: www.fda.gov/medwatch.

262) Tilting train interference problems

The high-speed tilting train project on the West Coast Main Line has been hit by more problems after tests revealed it can interfere with signals. The hitch was discovered during a non-passenger run of the Virgin Trains Pendolino train between Crewe and Liverpool. It was discovered that electromagnetic interference from the controls driving the motors on the trains can change the lights on the signals.

The roll-out of the service, which is planned to run between London and Scotland, has already been subject to delays. Network Rail – the company that has taken over from the Railtrack – said it was now discussing the problem with Virgin, the Strategic Rail Authority and the Alstom company, which is building the Pendolinos. There is speculation that train's traction motors might have to be redesigned and that special filters will need to be fitted to the signals.

But a Virgin spokesman insisted on Friday that the company did not anticipate having to put back the autumn 2004 date for the Pendolinos to switch from 110mph to a full tilting mode of 125mph.

The trains were due to be introduced in full 125mph tilt mode on the West Coast line in May 2002. But a series of delays have seen the cost of the West Coast upgrade reach £9.8bn and have meant the Pendolino project timetable has slipped. Virgin has so far received 15 of its 53 Pendolinos.

But they are only running at 110mph in non-tilt mode and only on Tuesdays between London and Wolverhampton and on Wednesdays and Thursdays between London and Manchester. Virgin hopes to run Pendolinos on five days a week by the end of the summer and, by 2006, reduce journey times between London and Scotland by about an hour to four hours 33 minutes.

(BBC News World Edition, Friday 2 May 2003, http://news.bbc.co.uk/2/hi/uk_news/england/2995355.stm. A similar item appears on Erik's Rail News for May 2003, at http://www.eriksrailnews.com/archive/may03.php, and we understand that another report on this interference problem appeared in the Daily Mail around the same time.)

A rail industry insider, who wishes to remain anonymous, brought the above news item to our attention – and adds the following comments…

The fact that interference is taking place at a number of different sites raises the issue of general safety procedures associated with the installation of new equipment within the railway.

It is likely that the interference is probably due to the introduction of new rolling stock using motor drive systems based upon fast switching power converters (refer to Tim Williams' article "EMC Threat to Broadcast Bands", Approval, Nov/Dec 2001, pages 26-30).

As well as the threat to radiocommunications at 150kHz and above, interference is produced by these switching converters in the frequency range 10kHz to 150kHz. Unfortunately, this is outside the range covered by the present family of railway EMC standards, EN 50121-1 to -5.

However EN 50121 (and the Protection Requirements of the EMC Directive) does require that all EMC phenomena be addressed in the EMC control process, i.e. all interference sources and levels are to be identified and only equipment with sufficient immunity to them should be installed.

In new railway projects this process works well with equipment being designed installed and tested to the requirements of meeting the emission and immunity requirements of the EN 50121 family of standards.

The problem is that much of the equipment installed in the UK railway is based upon so called 'grandfather rights', meaning that equipment that has been in use within the railway for many years with no EMC problems being reported, *can be used in new projects without having to meet EN 50121.*

Clearly, if the electromagnetic environment of the railway network remains the same, the use of 'grandfather rights' is justifiable. But if the EM environment is significantly changed by the introduction of a new major source of interference (such as the Pendolino? or the Eurostar – see Banana Skin No. 41) the use of the 'grandfather rights' approach must be questionable in any part of the railway where the new interference source is to be employed.

263) Railtrack did not know the electromagnetic susceptibility of much of its rail network

The following excerpts are taken from a hearing into complaints from rolling stock suppliers Adtranz and Alstom against the infrastructure operator (Railtrack) – regarding the inability of Railtrack to provide technical data (including EMC data) for acceptance of new rolling stock onto the UK rail network.

Adtranz/Alstom: Railtrack still does not know where its infrastructure is or how it performs. Nor does Railtrack know where its own infrastructure is non compliant with its own norms. The result has been that Railway Group Standards fail to define in key respects, mainly electromagnetic interference and gauging, the actual requirements that Railtrack will demand compliance to when trains are presented for approval.

Railtrack's fundamental failure to know where its infrastructure is, how it performs and the condition that it is in, continues to produce extraordinary turbulence in the requirements for safety acceptance.

We have £500 million vehicles parked in the sidings. All those vehicles are built within existing gauges. They are built with lower interference levels than any of the vehicles in service and we are trying to get those vehicles approved against criteria which are spiralling towards the impossible and left to individuals and subjective appraisal.

Railtrack: Railtrack's inherited infrastructure is 57,000 track circuits of a variety of different types. Many of them have been introduced over a number of years, tens of years, thirty years plus. Many of those track circuits were never designed for the concept of modern traction packages that we currently have being used today.

Most of them were originally designed for something like very statically controlled EMUs etc. A lot of those track circuits are susceptible to certain generated interferences that will come off these new trains. It is an inherent factor of the new train design. The track circuits which were installed and in many cases installed by BR do not necessarily meet today's standards.

Certainly the manufacturing requirement from Westinghouse or Alstom or previous companies that designed these track circuits would have designed it for work at a certain length. For reasons of fitting it to the infrastructure, the infrastructure will sometimes be of varying lengths, sometimes they are much longer in length because clearly if you could just increase it by 50% you can reduce the number of track circuits being fitted to the railway, has a nasty effect of making it far more susceptible to the EMC.

At the time the BR engineers did that, there was perfectly reasonable reason for doing it. They could make the track circuits work, they could make them reliable to operate the railway in a safe manner to detect trains. Unfortunately that same design criteria has made them more susceptible to the design of traction packages today.

Chairman: Sitting where we are if 15 years ago the British Railways Board had mandated that track circuit design ought to be a fairly limited range of track circuits that appeared to be roughly right in terms of emerging traction packages for the next ten years then we might not be sitting here now talking about electro-magnetic interference.

*(Taken from "*Hearing RE Adtranz/Alstom complaint about vehicle and route acceptance*", held on Tuesday 9th May 2000 at the Office of the Rail Regulator, London. Document reference 14419 Version 2 - Final. From: http://www.rail-reg.gov.uk/filestore/docs/adtranz-alstom.pdf or else go to the Rail Regulator's home page at http://www.rail-reg.gov.uk and enter 14419 into the search window.*

Note that the Eurostar trains are still not permitted to travel north of London because they can interfere with track circuits. This problem became public in 1996 – see Banana Skin No. 41 at http://www.compliance-club.com/archive1/Bananaskins.htm – but seven years later the problem still has not been fixed.

Other examples of railway interference problems can be found in the "Banana Skins compendium" via a link from www.compliance-club.com or at: http://www.compliance-club.com/archive1/Bananaskins.htm, especially (at the time of writing) numbers: 12, 42, 94 and 115.)

264) Potential for interference from railways

A report from York EMC Services for the Radiocommunications Agency has looked at the potential for interference from the various parts of the railway system. The following quotes summarise their conclusions:

"It is well known that the railway electromagnetic environment is much more severe than that found in most commercial and domestic premises. However, in many instances the railway runs very close to such premises. In fact, in the example of an inner city light rail scheme the railway effectively runs along public roads, which brings it into close proximity to non-railway premises and potential victim systems.

There are concerns about radio frequency emissions from railways and their potential to interfere with the operation of commercial radio services and other equipment, such as information technology equipment.

There is concern amongst CISPR and the radio community that the emission levels and measurement techniques set out in EN 50121 [the railways emissions standard] do not provide adequate protection to radio services. Some evidence has been found showing that such emissions are capable of interfering with electrical or electronic equipment and radio services operating adjacent to the railway lines. The findings of this study have implications for planned or existing buildings in which IT equipment will be used, where the buildings are situated very close (i.e. less than 10m) to electrified railway lines. There is a significant probability that the passing trains will interfere with PC monitors that are only a few metres away from the lines."

*(Taken from the Radiocommunication Agency's very helpful "*EMC Awareness*" website. When the RA was absorbed into OFCOM, this site was included in the 'Archives' section of their website, at: http://www.ofcom.org.uk/static/archive/ra/topics/research/RAwebPages/Radiocomms/index.htm.*

OFCOM have also made a link from their 'active' site to the EMC Awareness site as follows: On their homepage http://www.ofcom.org.uk, click on 'Legacy Regulator Archives'. Then click on 'Technology Research'. Then click on 'RA' (Radiocommunications Agency), which takes you to what was the RA's home page. Find the "EMC Awareness" box and click on it. The website is also hosted at: http://www.emcuk.co.uk/awareness.)

265) Radar detectors interfere with SKY TV

Radar detectors that warn drivers they are approaching a police speed trap can emit signals that cause interference to SKY digital television (and numerous other microwave communications systems).

Although it is suspected that this type of interference is widespread, only a small number of cases have been reported. This is because most people would attribute the freezing or break-up of their digital TV picture to a glitch in their equipment, or SKY's transmission, rather than interference. Relatively few people notice if this type of interference always occurs when a particular vehicle (fitted with a radar detector) passes their property.

The European Commission's Directorate on General Enterprise have been made aware that equipment approved to their Automotive EMC Directive 95/54/EC has been found to interfere with radio systems operating in the 10-20GHz frequency range. It used to be considered that products that came under the 95/54/EC and were 'e' marked were excluded from being covered by the EMC Directive 89/336/EEC and so did not require CE marking.

However, it is now the Directorate's opinion that 89/336/EEC applies to all of the EMC aspects that are not covered by 95/54/EC. Since 95/54/EC only covers emissions up to 1GHz, 89/336/EEC covers emissions from automotive equipment from 1GHz to 400GHz. Sadly, most of the applicable test standards under 89/336/EEC only test emissions to 1GHz, but at least the Protection Requirements of 89/336/EEC require that no interference is caused regardless of the frequency.

In the USA, where satellite TV is not very common, significant interference has occurred to satellite terminals used to link retail establishments with remote computers for verifying credit card transactions. Accordingly, the Federal Communications Commission (FCC) has announced that from August 2002 all radar detectors manufactured or imported in the USA must meet the Part 15 emissions limits in the 11.7-12.2GHz band.

*("*Proposed changes in the Guidance to the Automotive EMC Directive 95/54/EC and the EMC Directive 89/336/EEC to jointly impose both "e Marking" and "CE Marking" on vehicles and vehicle equipment*", ERA Technology Ltd, Safety and EMC Newsletter, Number 68, April 2003, page 7. Also see: "*FCC stiffens rules for radar detectors*", Conformity, September 2002, page 8. http://www.conformity.com. And: "*All radar detectors marketed must be FCC approved effective October 27, 2002*", DA 02-2852 October 28 2002, http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-02-2852A1.pdf?date=021028.)*

When comparing the phenomena regulated by both Directives it becomes apparent that harmonised standards under 89/336/EEC cover a wider range of phenomena than regulated by 95/54/EEC. The latter Directive limits itself to regulating radiated emissions below 1 GHz and for safety critical components regulates higher levels of immunity. This thus implies that it doesn't harmonise all the protection requirements specified in Directive 89/336/EEC, reason for which it is incorrect to argue that Directive 89/336/EEC doesn't apply to such products at all. A logical line of thought is that it only ceases to apply for the phenomena, which are regulated by the automotive EMC Directive and thus continues to apply for all other phenomena.

*(Taken from: "*Guidance in the EMC guide on the relation of the EMC and Automotive EMC Directive*" Brussels, 15 January, 2003, Ref: 07-28 EMC-AUTOMOTIVE, DG ENTR/G/3. Does this mean that motor cars should be CE marked, and have a Declaration of Conformity to the EMC Directive, after all?)*

266) Examples of interference with satellites

The wake shield experiment was launched in February 1994, but the small satellite used could not be deployed due to EMI with its attitude control system. This was caused by inductive coupling (crosstalk) between the unshielded attitude control sensor cable and the power bus of the spacecraft. This was an unpleasant lesson learned at the cost of a failed experiment.

The Gamma Ray Observatory satellite experiment launched in 1991 experienced a transponder lockup that prevented the spacecraft from receiving control commands. EMI from a ground source (plus design problems) was the cause.

The NOAA-11 weather satellite was launched in 1988. In September 1991 a series of phantom commands were observed and determined to be caused by EMI due to a noisy VHF (Very High Frequency) environment.

The NOAA-12 weather satellite was launched in 1991. In September 1991 it experienced phantom commands when it flew over Europe, due to the heavy commercial VHF environment over Europe.

*(The above incidents are items 2.2.2, 2.2.4, 2.2.5, and 2.2.6 in NASA Reference Publication 1374: "*Electronic systems failures and anomalies attributed to electromagnetic interference*" published in July 1995. Download it from: http://trs.nis.nasa.gov/archive/00000296/01/rp1374.pdf.)*

267) Saturn Launch Vehicle interference

During on-pad checkout at the Kennedy Space Centre prior to one of the early development test flights of the Saturn launch vehicle, the range safety receivers detected an extraneous signal. Because these receivers processed commands for engine cut-off, arm and destruct, a thorough investigation was conducted.

The spurious signals were caused by the multitude of telemetry transmitters located on board to collect test data, however, none of these were operating near the range safety receiver frequency.

Further investigation determined that the various RF signals were ‘mixing’ and producing intermodulation products in a non-linear circuit created by metalwork that was not properly bonded, namely the hinged cable tray covers and chain handrails on the gantry.

*(The above incident is item 2.1.1 in NASA Reference Publication 1374: “*Electronic systems failures and anomalies attributed to electromagnetic interference*” published in July 1995. Download it from: http://trs.nis.nasa.gov/archive/00000296/01/rp1374.pdf.)*

268) Safety-critical residual current detector (RCD) tripped by mobile phone

The 'incident', which occurred at a site handling radioactive material in 1996(?) was as follows: It was noticed that use of a mobile phone within approx. 1.5m of a portable RCD caused the RCD to trip. The RCD was connected in the supply to a monitor for 'in air' alpha particles. The concern was that such monitors connected via RCDs could be inadvertently tripped without being noticed. This could result in a failure to detect hazardous radiation levels.

Although, as far as I am aware, there was no such failure in this case. Portable radios caused the same effect up to 2.5m from the RCD. This illustrates a general principle that where electronic devices are employed for 'passive' monitoring to reduce risks to health or safety, steps should be taken to avoid such false tripping resulting from EMI, and regular tests carried out to verify the operation of the monitor. Hopefully, the immunity of RCD's has improved since the time of this incident, but the general principle remains.

(From Simon Brown of the UK’s Health and Safety Executive, 19th June 2003.)

269) USS Forrestal disaster

With the war in Southeast Asia providing experience for all phases of naval operations, several carriers which normally belong to the Atlantic Fleet were occasionally routed to WESTPAC duty, and thus it was that on June 6, 1967, Forrestal left Norfolk, Virginia, for what was to be her first combat deployment.

Carrying Air Wing 17, Forrestal was the first U.S. carrier to be built from the keel up with an angled deck. She carried East Coast squadrons, two F-4B squadrons squadrons; VFs 11 and 74; VAs 106 and 46, flying A-4Es; RVAH-11, with RA-5C Vigilantes, for which the big carrier had undergone major modification for the IOIC reconnaissance intelligence system; the KA-3Bs of VAH-10; and VAW-123, flying E-2As.

Forrestal arrived on Yankee Station on July 25 and immediately began combat operations, her aircraft flying 150 sorties during the next 4 days, without the loss of a single aircraft. At 10:52 A.M. on July 29, the second launch was being readied when a Zuni rocket accidentally fired from an F-4 Phantom parked on the starboard side of the flight deck aft of the island.

The missile streaked across the deck into a 400 gallon belly fuel tank on a parked A-4D Skyhawk. The ruptured tank spew highly flammable JP-5 fuel onto the deck which ignited spreading flames over the flight deck under other fully loaded aircraft ready for launch. The ensuing fire caused ordinance to explode and other rockets to ignite.

Spread by the wind, the flames engulfed the aft end of the stricken ship turning the flight deck into a blazing inferno.. Berthing spaces immediately below the flight deck became death traps for fifty men, while other crewmen were blown overboard by the explosion.

Nearby ships hastened to the Forrestal's aid. The Oriskany, herself a victim of a tragic fire in October 1966, stood by to offer fire-fighting and medical aid to the larger carrier. Nearby escort vessels sprayed water on the burning Forrestal and within an hour the fire on the flight deck was under control. But secondary fires below deck took another 12 hours to contain. The damage and loss of life was catastrophic.

The four-and-a-half-acre flight deck was littered with pieces of aircraft, as men struggled to clear away bombs and ammunition, throwing the ordnance over the side. One young 130-pound lieutenant found the strength to heave a 250-pound bomb overboard.

The Zuni rocket that was accidentally fired from an F-4 Phantom and started the fire is believed to have been triggered by a combination of the powerful fields at deck level from the ship’s radar and an incorrectly fitted shielded cable connector.

(*From http://forrestal.org/fidfacts/page13.htm*)

270 Government admits radio towers, units were too close

Eastern Creek has emerged as a possible site for Sydney's five commercial AM radio transmitters as the NSW Government admitted yesterday it approved residential development too close to the Homebush Bay towers. The Opposition has said the 1998 decision to allow Payce Constructions to build a 1200-unit residential development within 200 metres of the tower used by 2SM and 2UE was "a first-class bungle". But the Minister for Planning, Andrew Refshauge, said his department had acted with the best evidence before it and that no one had raised the issue of electromagnetic radiation from the towers when the masterplan was advertised in 1998. "There was no information to suggest radio broadcasts would cause any problem despite the fact the proposal was advertised widely. There was no submission made that would suggest that there was any problem."

The Herald reported yesterday that the Australian Communications Authority had warned PlanningNSW 14 months ago that there were concerns about electromagnetic radiation from the tower, which could cause serious interference with electrical and electronic equipment. The authority also raised potential health risks associated with exposure to high-powered electromagnetic radiation. Waterside, being built in Bennelong Road, is so close to the tower used by 2UE and 2SM that it is within the "drop zone" - the area usually kept clear in case a tower falls. This occurred recently in Brisbane, when DMG's tower was sabotaged and toppled, putting the station off air for several days.

The Opposition spokesman on planning, Andrew Humpherson, yesterday accused the Government of trying to cover up the debacle which he said had exposed taxpayers to substantial costs and claims for compensation, not just from the radio stations, but also from the developer and people who had bought the units. "We need answers. Just what was the Government aware of in 1998?" Mr Humpherson said.

Dr Refshauge's office said yesterday that there had been no submission from the broadcasters when the 1998 plan for residential development was exhibited. But the chief executive of Commercial Radio Australia, Joan Warner, said the industry had commented on the plan.

PlanningNSW, the Sydney Olympic Park Authority, broadcasters and the Australian Communications Authority are studying Eastern Creek as a relocation option.

(By Anne Davies, Urban Affairs Editor, Sydney Morning Herald, February 18 2003, http://www.smh.com.au/articles/2003/02/16/1045330466812.html, sent in by Chris Zombolas of EMC Technologies Pty Ltd., *www.emctech.com.au.*)

271) New type of light bulb claimed to interfere with satellite communications

A Maryland company will soon be manufacturing energy-saving light bulbs that almost never wear out. But a host of satellite radio broadcasters are crying interference.

According to a recent article in the Wall Street Journal, Fusion Lighting, Inc., of Rockville, MD, the manufacturer of the microwave powered bulbs, is drawing fire from Sirius Satellite Radio, Inc. and XM Satellite Radio Holdings, Inc. because the bulbs emit radio waves that directly interfere with satellite radio broadcasts. The year-long battle has seen the combatants engage in debate before the Federal Communications Commission (FCC), a private testing laboratory in Columbia, MD, and, in the near future, it appears, in courtrooms in Texas and Maryland.

Fusion began manufacturing specialty light bulbs in the 1970s, when its microwave powered ultraviolet bulbs were used in ink drying equipment in specialty industrial applications. The bulbs operated in frequency bands reserved for industrial, scientific and medical equipment.

When the company sold the ultraviolet business in 1994, Fusion's investors looked for broader applications for the light bulb technology, and hit on the idea of marketing the microwave bulb's energy efficiency and long life for broader commercial applications. Fusion says that it's now about a year away from commercial sales of the bulbs for use in lighting applications as diverse as gas stations and airport runways.

Trouble is that the lights make real the prospect of highways being lit up at night by hundreds of microwave bulbs that could, claim some, silence the satellite broadcasts. Understandably, the satellite broadcasters aren't standing for it, each having paid the government more than $80 million dollars for the right to broadcast on the contested frequencies.

Last year, the FCC attempted to broker a compromise between the parties, with Fusion eventually agreeing to reduce emissions from its bulbs by 95% by putting a metal casing around the microwave generator, using a metal reflector and coating the glass over the light. Not good enough, said the satellite broadcasters, who insisted on an emissions reduction of 99.9%. The FCC says that it's still months away from reaching a decision on the matter.

Meanwhile, Sirius has brought suit against Fusion, charging that Fusion executives "charged Sirius with securities fraud and dishonesty" in that company's efforts to raise additional capital. In its prospectus, Sirius mentions that "new devices may interfere with our service," but makes no mention of light bulbs. The CEO of Fusion reportedly raised the issue of Sirius' limited disclosure with a friend at Lehman Brothers Holdings, which was offering the Sirius shares, and the concern was eventually escalated to the underwriters handling the offering. Fusion has filed a countersuit against Sirius alleging defamation. (*From "*Bulb Manufacturer Lights Up Spectrum Wars", *News Breaks. Conformity, Vol. 6 No. 10, October 2001, www.conformity.com.*)

272) `Power Line Communication can interfere with radio astronomy

Power line communication (PLC) system which extends the available frequency bandwidth up to 30 MHz has been proposed in Japan. The electromagnetic interference problems on PLC had been investigated by the PLC study group organized by the Ministry of Public Management Home Affairs, Post and Telecommunications (MPHPT). The study group held collaborated field experiments of the PLC facility and we measured interferences caused by the PLC facility in the HF and UHF bands in order to evaluate the influences of the expansion of PLC bandwidth on radio astronomical observations.

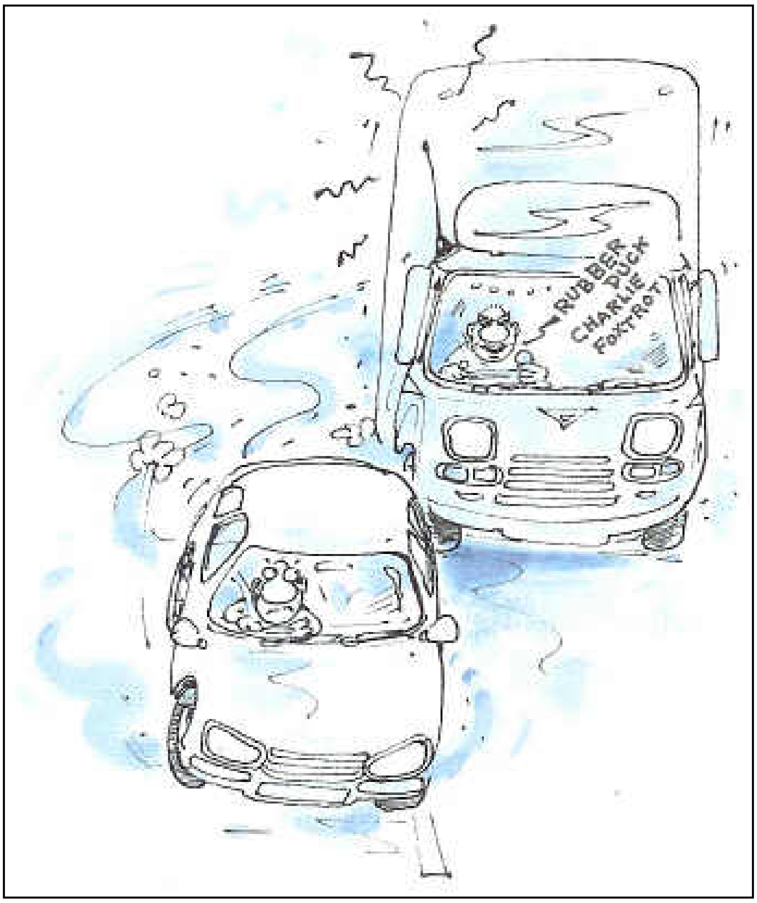
In the field experiment, two sets of PLC modems (SS and OFDM) were tested as an access system. During the PLC modems were on, the HF spectra observed showed strong increase of the noise-floor level, and it was found that the PLC noise exceeded the level of galactic noise by more than 30 dB. In UHF band, spurious emission around 327 MHz was identified. In both HF and UHF band, the interferences exceeded the limit of harmful interference level for radio astronomical observation which is given in Recommendation ITU-R TA769-1. Safety distances where the Recommendation was satisfied are estimated to be 219 km and 12 km at 9.2 MHz and 327 MHz, respectively. PLC seems to be a harmful interference source for the radio astronomical observation in both HF and UHF bands.

(*From: "*Interference measurements in HF and UHF bands caused by extension of power line communication bandwidth for astronomical purpose*", http://www.qsl.net/jh5esm/PLC/isplc2003/isplc2003a7-1.pdf. This item was found at: http://www.arrl.org/tis/info/HTML/plc, which has 24 pages of information and links on PLC/PLT.)*

273) Interference with early ABS and Airbag systems

Early ABS systems on both aircraft and automobiles were susceptible to EMI. Accidents occurred when the brakes functioned improperly because EMI disrupted the ABS control system. For aircraft, the initial solution was to provide a manual switch to lock out the ABS function when it was inoperable due to EMI and to use the normal braking system. Later, the solution was to qualify the ABS system prior to flight, based in the expected electromagnetic environment they would be exposed to.

For automobile systems, the solution was to ensure, if EMI occurs, that the ABS system degrade gracefully to normal braking – essentially an automatic version of the aircraft manual switch. Eventually, automobile ABS was qualified by EMI testing before procurement.



During the early years of ABS, a particular make of automobile equipped with ABS had severe braking problems along a certain stretch of the German Autobahn. The brakes were affected by a nearby radio transmitter as drivers applied them on a curved section of highway. The near-term solution was to erect a mesh screen along the highway to attenuate the EMI.

Mobile phones and passing taxi radios have been known to interfere with Anti-skid Braking Systems (ABS) and airbags, causing drivers to lose control of the car.

*(The above examples include items 2.3.1.16 and 2.3.1.17 from NASA Reference Publication 1374 (RP-1374), "*Electronic Systems Failures and Anomalies Attributed to Electromagnetic Interference*", which can be downloaded from: http://trs.nis.nasa.gov/archive/00000296/01/rp1374.pdf. They also include examples taken from "*Study to predict the electromagnetic interference for a typical house in 2010*" by Anita Woogara, Bristol University, & Smith Group, 17 September 1999 – this and many other interesting documents may be found by hunting around the (legacy) Radiocommunication Agency's website hosted on Ofcom's site at: http://www.ofcom.org.uk/static/archive/ra/rahome.htm"*

274) RSGB advice on identifying and locating sources of interference

The RSGB EMC Committee receives many enquiries from members about interference to reception of amateur radio signals. Accordingly, the RSGB (Radio Society of Great Britain) has produced a leaflet that gives advice about identifying and locating sources of Radio Frequency Interference (RFI, also called electromagnetic interference or EMI). Issues covered include…

- TVs, set-top boxes, Cable TV
- Switch-mode power supplies (e.g. 'lump in a cord' or 'plug-top' devices)
- Lighting
- Electric motors
- Thermostats
- Computers
- Intruder alarm systems
- Telephones and fax machines

(*Taken from the Radiocommunication Agency's useful "EMC Awareness" site at www.ofcom.org.uk/static/archive/ra/topics/research/RAwebPages/Radiocomms/index.htm, from its "Interference" section on: "Household Appliances and Electronic Equipment".*

(Note that since the RA was subsumed into OFCOM, www.ofcom.org.uk, in December 2003, all the old RA webpages are now running in the 'legacy' section OFCOM's website. The RA's site, of course, contains a great deal of valuable research that they had done into EMC, and this is also on OFCOM's legacy site as part of the original RA website. How long this valuable resource will be maintained by OFCOM is unknown. It is also not known if OFCOM are going to continue the RA's valuable research on EMC – more important, in these days of increasing spectrum use and more novel sources of interference, than ever before. If any OFCOM representatives would like to comment on these issues, we will be pleased to print their letters.)

275) Spacecraft engine disabled by voltage spikes

Europe's Smart-1 spacecraft, which is en route to the moon, has an engine problem that could leave the vehicle stranded in space. Engineers at the European Space Agency are hard at work on software they hope will rescue the probe, and plan to transmit it to the spacecraft next week. Smart-1 is powered by an ion thruster, which produces thrust in one direction by accelerating xenon ions in an electric field in the other direction. Although this creates only about the same thrust as the weight of a postcard, the engine works continuously, gradually increasing the size of the spacecraft's elliptical orbit until it is captured by the moon's gravitational field, a process that takes 15 months.

Soon after the spacecraft was launched, the engine started switching off repeatedly. The spacecraft's circuitry is sensitive to high-energy protons from the sun, which generate rogue voltage spikes. Engineers routinely build capacitors into circuits to mop up any voltage induced in this way. But after launch, the team found to its dismay that the mopping up feature had been omitted from some key circuits. Each time a high-energy proton hits a particular optical sensor, it generates a spike that causes the on-board computer to switch off the engine, called a "flameout".

(Taken from the "This Week" section, New Scientist, 31 January 2004, page 14, www.newscientist.com.)

276) 25,000 complaints of telephone interference in 1994

In 1994 the Federal Communications Commission (FCC) in the U.S.A. was receiving about 25,000 complaints per year from people unable to use their telephones because of interference from nearby radio stations. It is believed that this number represents only a tiny fraction of the actual instances of this type of interference.

The FCC's Field Operations Bureau (FOB) conducted a study, which found that although most residential telephones are susceptible to receiving interference, manufacturers can design telephones to be interference-free.

The transmitting stations most likely to be involved in interference complaints are citizens band (CB), broadcast, and amateurs. Transmitted power was not a significant factor: one-third of the transmitters used under ten watts. The study also found that filters cannot be relied upon to eliminate telephone interference. In two out of three cases in which they were tried during the study, they did not work.

(Taken from: "Interference Free Telephones", FCC (Federal Communications Commission, Washington D.C., U.S.A., News media information 202/632-5050, May 4, 1994, indexed at: http://www.fcc.gov/Bureaus/Common_Carrier/News_Releases/1994/index3.html, download from: http://www.fcc.gov/Bureaus/Common_Carrier/News_Releases/1994/nrcc4019.txt)

277) CAA tests reinforce the decision to restrict use of cellphones in aircraft

In October 2002, a set of avionic equipment was tested under controlled conditions in a test chamber for susceptibility to cellphone interference. General aviation avionic equipment, representative of earlier analogue and digital technologies, was used. The equipment, comprising a VHF communication transceiver, a VOR/ILS navigation receiver and associated indicators, together with a gyro-stabilised remote reading compass system, was assembled to create an integrated system.

The tests covered the cellphone transmission frequencies of 412MHz (TETRA), 940MHz (GSM900) and 1719MHz (GSM1800), including simultaneous exposure to 940 and 1719MHz. The applied interference field strengths were up to 50 volts/metre for a single frequency, and 35 volts/metre for dual frequencies.

The following anomalies were seen at interference levels above 30 volts/metre, a level that can be produced by a cellphone operating at maximum power and located 30cms from the victim equipment or its wiring harness.

- Compass froze or overshot actual magnetic bearing.
- Instability of indicators.
- Digital VOR navigation bearing display errors up to 5 degrees.
- VOR navigation To/From indicator reversal.
- VOR and ILS course deviation indicator errors with and without a failure flag.
- Reduced sensitivity of the ILS Localiser receiver.
- Background noise on audio outputs.

Most anomalies were observed at 1719MHz.

The results of the tests endorse current policy that restricts the use of cellphones in aircraft.

The CAA will remind operators about the specific risk from cellphone usage on the flight deck, and recommend that confirmation be obtained from passengers at check-in that cellphones in their luggage have been switched off

(Taken from the Radiocommunication Agency's "EMC Awareness" website, now at: http://www.ofcom.org.uk/static/archive/ra/topics/research/RAwebPages/Radiocomms/index.htm. The website is also hosted at: http://www.emcuk.co.uk/awareness.)

278) Interference issues on a research and recovery vessel

The experiences of the crew of the research vessel (R/V) Deep Scan, a privately owned research and recovery ship, offer some insight into the complexities of integrating commercial off-the-shelf (COTS) computing equipment into a shipboard electromagnetic environment.

R/V Deep Scan is constructed as a commercial vessel with many of the electrical characteristics of military mine-clearing ships. Its hull and deck structures are constructed from wood, closed cell foam and fibreglass, and it shares EMI/EMC problems common to non-metallic ships.

Computing equipment on board is said to be compliant with FCC Part 15 for radiated emissions. A commercial workstation processes sonar and navigation track data from multiple transducers. A 386 PC processes both electromagnetic survey data from multiple detection transducers and data for navigation. Navigation data is provided by COTS GPS (Global Positioning System) and LORAN-C receiver systems. Depth information is provided by COTS depth sounding equipment. Heading data is provided by a COTS fluxgate compass.

Operating the marine VHF transmitter at more than 1W begins to corrupt collected data, and any use of HF SSB transmission causes the COTS computing equipment used for magnetic data collection and navigation to enter states that challenge rational explanation.

FCC rules limit the levels of unintentional electromagnetic radiation, but the close proximity of COTS computing equipment (the vessel is under 60 feet long) to the antennas used for data collection and communications is largely responsible for disruption of operations due to the EMI the COTS equipment generates.

EMI generated by the switching power supplies in the COTS equipment slightly degrades the LORAN-C signal-to-noise ratio through radiated coupling. COTS computing equipment generates sufficient radiated interference on the HF bands to render HF communications impractical. Broadband interference and harmonics from COTS computing equipment interfere with communications reception on selected VHF channels, in some cases enough to prevent useful communications.

Daily operations on board R/V Deep Scan are influenced by the EMI and susceptibility problems associated with the use of COTS computing equipment. Responding to a call on the VHF radio presently requires the crew to wait for a logical break in survey operations, or requires termination of survey operations. During survey operations, monitoring some VHF channels is not possible, HF transmission is impossible and HF reception is seriously degraded.

*(Taken from the Radiocommunication Agency's "*EMC Awareness*" website, now at: http://www.ofcom.org.uk/static/archive/ra/topics/research/RAwebPages/Radiocomms/index.htm. The website is also hosted at: http://www.emcuk.co.uk/awareness.)*

279) Inverter drive interferes with ultrasonic level sensor at water treatment plant

Problems associated with electrical noise have been solved at Northumbrian Water Broken Scar water treatment works in Darlington, County Durham. Such problems are an inevitable element of major pump installations, especially where large inverter drives are involved. This is sometimes a major problem for instrumentation, which generally involves cables carrying a smaller signal between a sensor and a control and analysis unit.

At Broken Scar, a large inverter drive meant that there was very high electrical noise. The ultrasonic level measurement unit that was originally installed, which used a coaxial cable to carry a signal, was swamped and unable provide a reliable measurement. The solution was a Pulsar ultrasonic level measurement system …. performing an initial (digital) conversion on the signal at the transducer head, communicating digital information to the signal analysis. Despite the noise still being present, the system can discriminate between noise and the "true" signal to give a reliable measurement.

(Adapted from an advertisement for Pulsar Process Measurement Ltd, in Plant and Control Engineering Magazine, Oct/Nov 2003, page 11.)

280) Mains supply dips getting worse

We have seen an increase in AC mains supply dips from typically seven per year to eighteen, which is causing increased losses in production.

*(A comment by a representative from a major steel manufacturing company at the IEE's Wales South-East & Wales South-West Power Specialist section's "*Power Quality Seminar*", held at the University of Wales Swansea on Wednesday 12th November 2003.)*

281) Increasing interference with Public Safety Communications in USA

Signals from wireless communications transmitters are continuing to create significant interference issues for public safety officials, according to a recent report in the Washington Post. The interference problems reportedly stem from the close proximity of spectrum allocations for public safety communications and some older style wireless telecommunications technologies, which operate in the 800 Megahertz band. As we've previously reported (see Conformity, August 2002), more than 70 government agencies in 27 states have reported interference problems with wireless communications services used by public safety officials.

According to the *Post* article, communications problems most often arise when a public safety official (such as a police officer) is far from a transmitter that carries emergency radio signals but close to a transmitter for a wireless system carrier. In these cases, the signal from the wireless system overwhelms the weaker emergency signals, effectively blocking emergency communications.

The communications system operated by Nextel Communications appears to remain the principal source of most of the interference complaints. The Nextel network was originally cobbled together in the 1980s from underutilized portions of spectrum allocated for limited specialty uses. However, as the Nextel network has grown, its use of spectrum has begun to overlap with the frequencies used by public safety agencies.

State and municipal public safety authorities are responding in various ways to the continuing problem. Some jurisdictions are attempting to upgrade the communications infrastructure to provide stronger signals to radios operating on public safety bands. Still others are attempting to pass ordinances that require wireless carriers to certify that their signals do not interfere with public safety communications. Meanwhile, some police officers have reportedly found a simpler solution to interference with public safety communications bands, They carry their own cell phones!

*(From: "*Wireless Interference with Public Safety Communications Growing*", Conformity, November 2003, pages 8 and 10, http://www.conformity.com.)*

282) Interference issues within UK railway networks

Historically, EMC issues on railways have been dominated by the possibility of interference from high power electric traction supplies, particularly DC, affecting safety-critical low power train detection equipment. The introduction of switched traction controllers raised further concerns and early variable frequency chopper drives have caused incidents, leading to the adoption of fixed frequency choppers for DC traction drives. By the time traction inverter drives for AC traction became commercially attractive, due to the introduction of GTO thyristors and subsequently IGBTs, the potential risk was well understood and care has been taken to design traction drives to be compatible with train detection systems, either by design or high-integrity monitoring.

Now, probably the greatest threat to train detection is to older track circuits operating on the same frequency as the AC utility used to produce the DC traction supply and older trains without power electronic traction controllers. In a recent incident on the UK network, a failure on the rectifier of a DC traction supply was detected by a number of new power electronic trains being brought to a halt by their interference current monitoring units even though each train was perfectly healthy.

*(From: "*GM/RT8015 and Safety*" by Jeff Allen and David Bulgin of the Rail Safety and Standards Board, presented at the IEE Seminar "*EMC Assurance in a Railway Environment*", 9th September 2003, www.theiet.org.)*

283) New Automotive EMC Directive includes transient immunity tests

As part of the development of this directive (*Automotive EMC, 2004/104/EC – Editor*), it has become evident that many aftermarket devices can be found to be susceptible to the many switching events on a vehicle. This can be simply audio clicks or, worst case, result in hardware failure of the component resulting in damage to the vehicle itself.

For this reason, and following lobbying by the vehicle manufacturers, the committees responsible for the directive have included in this latest draft requirements for all ESAs *(electronic sub-assemblies – Editor)* to be immune from a series of transient events.

*(From: "*Transient Test Requirements for "e"-Marking – Necessity or Bureaucracy?*", by James Gordon-Colebrook and Alex Mackay of 3C Test Ltd, presented at the Automotive EMC 2003 Conference, 6th November 2003, http://www.AutoEMC.net.)*

284) EMC Problems with Speed Detection Cameras cost Victoria Government AUS$30 Million

The state government of Victoria, Australia, has commissioned a special investigation into the Fixed Digital Speed Detection Cameras. This follows from the report of the independent testing of the fixed digital speed detection cameras, commissioned by the Department of Justice after concerns were raised about erroneous readings and incorrect infringement notices. On-site testing, engineering investigations and EMC testing showed the occurrence of both ‘over-readings’ and ‘under-readings’. The faulty readings were due to electromagnetic interference, poor installation and maintenance and degradation of the in-road sensors.

The faulty speed readings resulted in the issuing of fines and cancellation of driving licences, and this has called into question the reliability of electronic equipment used throughout the state's traffic control measures and for other law enforcement activities. Many motorists who have had their licences cancelled are threatening to sue the state for damages and consequential losses. The State government has allocated about AUS$30 million to reimburse the fines imposed on motorists and to compensate those with claims for losses resulting from licence suspension due to penalties from the flawed cameras. The government will also have to meet the cost of replacing or improving the 41 fixed cameras throughout the city's road grid.

*(From Chris Zombolas, EMC Technologies Pty Ltd., Melbourne, Australia, www.emctech.com.au. Also see the media release from the Premier of Victoria, Friday, 14 May 2004: “*Government acts on fixed speed cameras*”; http://www.justice.vic.gov.au/speedcameras; and Melbourne Age, 15 May 2004: “*$26 million Speed Payout*”.)*

285) TETRA interference with TV reception

The new emergency services radio system, called Airwave, has been blamed for interfering with television reception, but where the problems occur the fault lies with the filters on domestic aerial amplifiers. Trade and Industry Minister Steven Timms, in a Parliamentary written answer, said: “OFCOM is aware of instances of interference to domestic installations from Airwave radio base stations. In all the instances so far investigated the consumer’s own masthead aerial amplifier, used to boost weak signals, has had a pass-band wide enough to boost the television signal and, inadvertently, the unwanted radiocommunications signal *(from Airwave – Ed.)*.”

Airwave is being rolled out across Great Britain for police and public safety communications, with completion due by 2005, when existing frequencies will be withdrawn. It is a digital system based on the ETSI-approved TETRA (Terrestrial Trunked Radio) standard.

Mr Timms went on: “Testing has shown that the TETRA transmitters were operating correctly and within their designated licence parameters. In most cases a suitable filter fitted between the masthead amplifier and the TV aerial will resolve the interference, and affected residents have been advised to have such filters fitted. As a goodwill gesture Airwave has arranged for filters to be fitted to the affected television installations in certain circumstances.”

*(“*Aerial amplifiers cause Tetra TV interference*” from the IEE’s EMC Professional Network’s “EMC Industry News 2004-01-15”, 18th January 2004, www.theiet.org. TETRA has also caused significant problems for radio activated vehicle security systems, see Banana Skin No. 54. Other Banana Skins that mention TETRA are: 121, 122, 124, 252, 255 and 277.)*

286) Electronic organ manufacturer fined for EMC non-compliance

The Enforcement Bureau of the Federal Communications Commission (FCC) has fined a Dutch company for importing and marketing in the United States electronic organs which radiated emissions in excess of U.S. limits. The company, Johannus Orgelbouw b.v. of the Netherlands, was fined US$7000 and ordered to submit to the FCC for the next two years verification records for each model of organ which it imports into the U.S.

The matter of the emitting digital electronic organ was brought to the attention of the Enforcement Bureau in early 2003 by a competitor who claimed that other organ companies were suffering competitive harm because the company, by not complying with FCC regulations, was able to produce products less expensively. In a subsequent investigation by FCC agents, the company acknowledged that it had imported and marketed at least one model of organ that did not comply with FCC emissions limits, resulting in the Commission’s action.

*(From “*FCC Fines Importer of Non-Compliant Electronic Organs*”, Conformity, News Breaks, February 2004, pp 42-43, www.conformity.com.)*

287) False alarm in the Bahamas, caused by inadequate immunity of field meter

Once upon a time, when the Bahamas telephone toll center transactions were only $175,000 US per day — and EMC engineers made a great deal less — our facilities safety manager was attending to his appointed rounds with his brand-new, brand name RF field intensity meter in hand. He wanted to make sure that the electric fields within the facility were less than the allowed maximum of 10mw/sq.cm (194 V/m). After all, our company didn't want to accidentally cook anyone that worked there. It wouldn't look good come time to renew their management contract.

Much to the safety engineer's surprise, the fields being presented by the video display units (VDUs) at the operator consoles were way above the maximums. A quick calculation disclosed that the measured field intensities were in excess of 300 V/m. Did he call anyone? Did he ask how that was possible? Of course not! Being a good safetyman, with genuine concern for the workforce, he immediately shut down the toll center. Then, he called to report his findings. Then, his boss called corporate headquarters and they called my boss and also those of six other EMC facilities that we had scattered around the world. Then seven EMC engineers, myself included, immediately reported to the Bahamas to solve this serious problem. At $175,000 per day there was a lot of incentive to get there quickly.

We were prompt, but still didn't arrive at the same time. But when we did, we found that the first EMC engineer on the scene had already discovered that the brand-new, brand name RF field intensity meter was susceptible to the 15kHz VDU raster sweep frequency, and the toll center was back on-line. Of course, this required an appropriate celebration at a little place nearby… but that's a different story!

("A really short 'vacation' in the Bahamas", Ron Brewer, IEEE EMC Society Newsletter, Spring 2004, 'Chapter Chatter' section, page 8, www.ewh.ieee.org/soc/emcs.)

Numbers 288 - 298 below are taken from the Appendix to MIL-STD-464A dated 18 March 1997.

(MIL-STD-464A is entitled "Department of Defense — Interface Standard —Electromagnetic Environmental Effects — Requirements for Systems". To obtain a free copy, type MIL-STD-464 into the Google search engine at http://www.google.com, and it will quickly find sites from where it can be downloaded.)

288) From MIL-STD-464A A.5.2 "Intra-system electromagnetic compatibility (EMC)"

When appropriate controls are implemented in system design, such as hardening, EMI requirements on subsystems and equipment, and good grounding and bonding practices, there are relatively few intra-system EMC problems found. Most problems that are found involve antenna-connected transmitters and receivers. Receiver performance has been degraded by broadband thermal noise, harmonics, and spurious outputs coupled antenna-to-antenna from transmitters. Microprocessor clock harmonics radiating from system cabling and degrading receivers have been another common problem. Electromagnetic fields radiated from onboard antennas have affected a variety of subsystems on platforms.

Typical non-antenna related problems have been transients coupled cable-to-cable from unsuppressed inductive devices and power frequencies coupling into audio interphone and video signal lines. Problems due to cable-to-cable coupling of steady state noise and direct conduction of transient or steady state noise are usually identified and resolved early in the development of a system. Generation of broadband EMI on ships from electrical arcing has been a common source of degradation of antenna-connected receivers and must be controlled. Sources of the arcing have been brush noise from electrical machinery and induced voltages and currents between metallic items from antenna transmissions. Intermittent contact of the metallic items due to wind or ship motion is a contributor.

289) From MIL-STD-464A A.5.3 "External RF EME" (EME means electromagnetic environment, used in this document to mean only the radiated environment)

High-powered shipboard radars have caused interference to satellite terminals located on other ships, resulting in loss of lock on the satellite and complete disruption of communication. The interference disables the satellite terminal for up to 15 minutes, which is the time required to re-establish the satellite link. Standoff distances of up 20 nautical miles between ships are required to avoid the problem.

A weapon system suffered severe interference due to insufficient channel selectivity in the receiver's front end. Energy originating from electronic warfare systems and another nearby "sister" channelized weapon system (operating on a different channel but within the same passband) coupled into the victim receiver and was "processed," severely degrading target detection and tracking capability.

Installation of an electronically tuned filter immediately after the antenna countered the off-channel interference problem by: 1) eliminating receiver front-end amplifier saturation and 2) reducing overload of the system processor with extraneous in-band signals.

An aircraft lost anti-skid braking capability upon landing due to RF fields from a ground radar changing the weight-on-wheels signal from a proximity switch. The signal indicated to the aircraft that it was airborne and disabled the anti-skid system. An aircraft experienced uncommanded flight control movement when flying in the vicinity of a high power transmitter, resulting in the loss of the aircraft. If the mission profile of the aircraft and the anticipated operational EME had been more accurately considered, this catastrophe could have been averted.

Aircraft systems have experienced self-test failures and fluctuations in cockpit instruments, such as engine speed indicators and fuel flow indicators, caused by sweeping shipboard radars during flight-deck operations. These false indications and test failures have resulted in numerous unnecessary pre-flight aborts.

Aircraft on approach to carrier decks have experienced interference from shipboard radars. One such problem involved the triggering of false "Wheels Warning" lights, indicating that the landing gear is not down and locked. A wave-off or preflight abort could occur due to this EMI induced condition.

Aircrews have reported severe interference to communications with and among flight deck crew members. UHF emissions in the flight deck environment caused interference severe enough that crews could not hear each other for aircrew coordination. This problem poses a serious hazard to personnel with the potential for damage to, or loss of, the aircraft and aircrew during carrier flight deck operations.

290) From MIL-STD-464A A.5.4 "Lightning"

The effects of lightning can cause physical damage to personnel and equipment. In one of numerous documented lightning incidences, lightning appeared to enter a Navy aircraft nose, travel down the right side, and exit on top of the right vertical tail. The pilot suffered from flash blindness for 10-15 seconds. Upon regaining his vision, the pilot noticed all cockpit electrical power was gone. After another 15 seconds had elapsed, all cockpit electrical power returned on its own, with no cockpit indications of any equipment malfunction.

In another case, lightning attached to the nose pitot tube, inducing transients that damaged all 28 volt DC systems. The pilot, disoriented, broke out of a cloud bank at 2000 feet above the ground, at 600 knots and a 45 degree dive. Nearly all cockpit instruments were dysfunctional - compass, gyrohorizon, and so forth. A secondary effect occurred but was not uncovered for several months. The lightning current path that carried the direct effects lightning current did what it was supposed to do, but the path was not inspected on landing.

Over 800 man-hours were expended to correct electrical (28 volt DC) problems but no effort went into inspecting for direct effects damage to ensure the lightning protection system was intact. The rigid coax from the front of the radome to the bulkhead had elongated and nearly torn away from its attachment point at the bulkhead due to magnetic forces involved. This damage reduced the effectiveness of the designed lightning protection. Another secondary effect was the magnetization of all ferrous material which caused severe compass errors. The entire aircraft had to be degaussed.

291) From MIL-STD-464A A.5.6.1 "Non-developmental items (NDI) and commercial items"

Several instances have been noted in ground-based applications where EMI emissions from commercial digital processing equipment have interfered with the operation of sensitive radio receivers. Of particular concern are radiated emissions from processor clock signals causing interference with communications equipment that operates from 30 to 88 MHz. Most commercial equipment is qualified by testing at a distance of three meters. The problems have been largely caused by use of the commercial items at distances of one meter or closer where the fields will be higher.

Another example is a commercial global positioning system (GPS) receiver interfering with a military GPS receiver. The out-of-band antenna emissions from the commercial receiver were picked up by the antenna of the military receiver and processed at the in-band frequency. A limited CE106 test may have identified the emission.

292) From MIL-STD-464A A.5.14 "EM Spectrum Compatibility"

Currently there are numerous incidences of co-site, intra-ship, and inter-ship interference, as well as interference with the civilian community. For example, the Honolulu Airport air traffic control radars have been degraded by shipboard radars stationed adjacent to Pearl Harbor.

A program manager developed a system without requesting spectrum certification. After development, it was discovered that the system had the potential to interfere with other critical systems. Costly EMC testing and operational restrictions resulted, impacting the ability to meet mission requirements. Both items could have been avoided if spectrum management directives had been followed.

A base communications officer funded the purchase of commercially approved equipment. The user was unable to get a frequency assignment because the equipment functioned in a frequency range authorized for only non-government operation. A second system had to be purchased to satisfy mission requirements.

293) From MIL-STD-464A A.5.7 "Electrostatic charge control"

A maintenance person was working inside a fuel tank and experienced an arc from his wrench when removing bolts. It was found that maintenance personnel were routinely taking foam mats into the tank to lie on while performing maintenance. Friction between the mat and clothing allowed a charge buildup which caused the arc. All static generating materials should be prohibited from the tank during maintenance.

Many equipment failures have been attributed to ESD damage of electronic parts.

294) From MIL-STD-464A A.5.7.1 "Vertical lift and in-flight refueling"

To protect personnel on the ground from receiving electrical shocks, it is standard practice for rotorcraft to touch the ground with the hook before it is connected to the cargo. As the cargo is lifted, the whole system (aircraft and cargo) will become recharged. Again, when the cargo is lowered to the ground, it must touch the ground to be discharged before handling by personnel. The aircraft system and cargo often see several electrical discharges as the vertical lift process is executed.

During in-flight refueling, pilots have reported seeing arcing between the refueling probe and the fueling basket during mating. These discharges were several inches long. Based on these observations, the 300 kV number was derived. Aircraft that have experienced discharges from in-flight refueling have had upsets to the navigation system resulting in control problems.

295) From MIL-STD-464A A.5.7.2 "Precipitation static (P-static)"

A.5.7.2 A fighter aircraft was experiencing severe degradation of the UHF receiver when flying in or near clouds. Investigation revealed that the aircraft was not equipped with precipitation static dischargers. Installation of these devices solved the problem.

An aircraft had a small section of the external structure made of fiberglass. Post-flight inspections required personnel to get in close proximity to this non-conductive structural component. On several occasions, personnel received significant electrical shocks which caused them to fall from ladders and be injured. Corrective action was easily accomplished be applying a conductive paint to the surfaces exposed to airflow and personnel contact.

Static discharges from the canopy were shocking pilots on a fighter aircraft during flight. Charges accumulating on the outside of the canopy apparently migrated slowly through the dielectric material and discharged to the pilot's helmet when sufficient charge appeared on the inside surface. A grounded conductive finish on the inside of the canopy fixed the problem. Experience with an ungrounded conductive finish aggravated the problem.

When an aircraft was flying in clouds during a thunderstorm, the pilot was unable to transmit or receive on the communications radio. Further investigations were performed with the most reasonable conclusion that the radio blanking was caused by electrostatic discharge. Several incidents were also reported where pilots and ground crews received shocks due to static discharges from aircraft canopies. These incidents occurred on the carrier deck after the aircraft had been airborne for several hours.

It was discovered on an aircraft that was experiencing p-static problems that the static dischargers had been installed using an adhesive that was not electrically conductive.

Coordination between structural and electrical engineer personnel is necessary to ensure that all required areas are reviewed. For example, a structural component on an aircraft was changed from aluminum to fiberglass and experienced electrostatic charge buildup in flight which resulted in electrical shock to ground personnel. The structural engineer made this change without proper coordination, which resulted in an expensive modification to correct the shock problem.

296) From MIL-STD-464A A.5.7.3 "Ordnance subsystems"

Explosive subsystems have been initiated by ESD caused from human contact or other sources of ESD.

297) From MIL-STD-464A A.5.8.3 "Hazards of electromagnetic radiation to ordnance (HERO)"

Several incidences onboard Navy ships involving the inadvertent firing of rockets and missiles have resulted in catastrophic loss of life and equipment. There have been numerous explosive mishap reports involving RF induced, uncommanded actuation of automatic inflators worn by aircrew personnel both on flight decks and in-flight while launching from and landing on the carrier. These problems pose a tremendous hazard to aircrews, especially those in-flight at the time of occurrence.

298) From MIL-STD-464A A.5.11.1 "Aircraft grounding jacks"

Aircraft fuel fires have been attributed to electrostatic discharge. Precisely demonstrating that an electrostatic discharge caused a mishap is usually not possible due to difficulty in reproducing conditions that were present.

Grounding jacks on aircraft in the field have been found to be electrically open-circuited with respect to the aircraft structure due to corrosion. It is important that corrosion control measures be implemented at the time of installation.

299) Patriot system interference blamed for shooting down UK fighter plane

The latest Patriot scandal concerns the deaths of the crew of Yahoo 76, a British Tornado GR-4 that was shot down by a Patriot air and missile defences unit over Kuwait on 22 March last year as it descended with another Tornado in a pre-planned "safe" corridor towards its home base west of Kuwait City.

What the data shows is that the Patriot did not initially identify the Tornado as a target at all, and that the "missile" it registered was in fact a "ghost" – an illusion probably generated by electronic interference from other nearby Patriot units. Furthermore, the Patriot detected this false target 15 kilometres east of the approaching Tornados, heading not towards the Patriot but towards a troop encampment roughly 15 kilometres to the north. If it had been heading towards the Patriot, the battery's weapon control computer would have classified it as an Air Threat Category 1. Instead, it classified it as a Category 9, a threat level so low that the computer did not even mark it for engagement.

The Patriot's crew, believing they were under attack, launched an Interceptor missile at the false target, which by this stage had "moved" into the vicinity of the Tornados. In the absence of any other target, the interceptor's radar homed in on one of the planes.

*(Taken from: "*Unfriendly Fire*", by Theodore Postol, Professor of Science, Technology and National Security Policy at the Massachusetts Institute of Technology, New Scientist, 2 October 2004, page 23, www.newscientist.com.)*

300) Electromagnetic effects due to UFOs

Reports of anomalous aerial objects (AAO) *(UFOs to the rest of us – Editor)* appearing in the atmosphere continue to be made by pilots of almost every airline and air force of the world in addition to private and experimental test pilots. This paper presents a review of 56 reports of AAO in which electromagnetic effects (E-M) take place on-board the aircraft when the phenomenon is located nearby but not before it appeared or after it had departed. These effects are not related to the altitude or airspeed of the aircraft. The average duration of these sightings was 17.5 minutes in the 37 cases in which duration was noted.

There were between one and 40 eye witnesses (average = 2.71) on the aircraft. Reported E-M effects included radio interference or total failure, radar contact with and without simultaneous visual contact, magnetic and/or gyro-compass deviations, automatic direction finder failure or interference, engine stopping or interruption, dimming cabin lights, transponder failure, and military aircraft weapon system failure. There appears to be a reduction of the E-M energy effect with the square of increasing distance to the AAO. These events and their relationships are discussed. This area of research should be concentrated on by other investigators because of the wealth of information it yields and the physical nature of AAO including wavelength/frequency and power density emissions.

(As usual, we celebrate another *hundred Banana Skins with something a little more unusual, tongue-in-cheek, or just plain funny. Make up your own mind about which category this one falls into.* ***It was t****aken from the Abstract for "*Fifty-six Aircraft Pilot Sightings Involving Electromagnetic Effects*", by Richard F. Haines, Ph.D, Copyright 1992, http://www.nicap.dabsol.co.uk/92apsiee.htm, 16 Jun 03.)*

301) Immunity to interference degrades over time

EMI hardness evaluations under the Navy's Air Systems' EMI Corrective Action Program (AEMICAP) have shown that the hardness of aircraft is degraded over time. Electrical inspections have shown numerous instances of foreign object damage, excessive chaffing of wires, and improper splicing and terminations. Bonding measurements performed over a ten year period on a Navy fighter aircraft indicates 10-15% out of specification conditions on a new aircraft, 40-60% out of specification conditions on a five year old aircraft and 70-80% out of specification conditions on a ten year old aircraft. These out of specification bonding conditions result in inadequate termination of shields and boxes and degrade shielding effectiveness.

During EMC tests, the effects of corrosion and maintenance practices on the EMC design have been noted. For example, composite connectors were incorporated in the pylons of a Navy attack aircraft to correct a severe corrosion problem on the existing aluminum connectors. The composite connectors are more resistant to the corrosion than aluminum. They do, however, oxidize and produce a powdery residue on the connector. The maintenance personnel would then wire brush this residue, thereby eliminating the outer conductive coating, severely degrading the connector conductivity, and introducing potentially more severe corrosion problems.

*(Taken from MIL-STD-464A, Appendix A.5.9 "*Life cycle, E3 hardness*". 'HERO' stands for Hazards of Electromagnetic Radiation to Ordnance.)*

302) Early colour TV interference from early police radio handset, warns criminals

About the time of the introduction of 'Panda' cars in the UK came a new Police hi-tech system known as the Personal Radio. In many Police forces this consisted of a pair of UHF radios, a transmitter and a separate receiver. The receiver was the more interesting of the two from an EMC point of view. Crystal controlled, single frequency and not much bigger than a packet of king size cigarettes, it had a vicious local oscillator that radiated very strongly.

The introduction of Police PR radios came about at the same time as the UK was just getting switched on to colour television. Regrettably, immunity from RF interference was not one of the finer qualities of this new entertainment system. I recall being told a story by Alan who was a licensed Amateur Radio colleague who happened to be a local Policeman. Apparently, invited (?) into someone's home one day, the proud owner of his new colour television was watching a programme in glorious and over-saturated colour. Much to the annoyance of it's owner, the television suddenly reverted to a black and white picture when Alan and radio walked into the room. Alan quickly turned off his PR receiver and the colour returned. Further tests revealed that even if he stood outside the front door of the terraced house with his PR receiver switched on, the TV was determined to stay in black and white until he walked away.

Allegedly this phenomenon was quickly communicated in criminal circles. Alan told me that it was no coincidence that more than one or two criminals were seen to run out of the back door before the bobby actually knocked on the front door. It seems that the early warning system was not just confined to Fylingdales in those days!

(Sent in by Graham Eckersall, G4HFG / W4HFG, Approvals Manager, Barcrest Group, July 13 2004.)

303) Power quality problems will get worse

The widely publicized breakdowns and subsequent blackouts in the public power networks of the Northern United States and several European countries are extreme examples of phenomena that occur on a smaller scale many times every day. Studies have shown that Dips, or "brown-outs", and Interrupts, or "dropouts", in the public power supply are tending to increase in frequency in our overstretched power networks, causing further degradation in the quality of the electric power supply. The results of power interruption can cause equipment reset and data loss, resulting in such consequences as breakdown of production or even danger to life.

The situation is not going to improve in the short term. As more functions are packed into increasingly smaller volumes, power consumption inevitably increases. Further, the increased use of microprocessors means that equipment incorporating them is potentially more susceptible to power line fluctuations.

*(Taken from "*Dips/Interrupts Testing Gets an Update*", by Martin Lutz and Nicholas Wright, Conformity, November 2004, page 12, www.conformity.com.)*

304) Interference problems within a vehicle

When I sampled the Audi A3 Sportback recently with this same choice of transmissions, I could not decide which I preferred. For the GTI I emphatically opt for the conventional manual: even with the ESP (Electronic Stability Program) disabled, in versions fitted with DSG there was excessive interference from background electronic systems. Requests via my right foot for full-throttle acceleration would often be refused for several frustrating seconds.

*(Note from the Editor: DSG stands for Direct Shift Gearbox, a semi-automatic gearbox with a steering wheel-mounted 'paddle change' and no clutch.) (Taken from: "*Regeneration*" by Peter Dron, a motoring review of the latest VW Golf GTI, in the Daily Telegraph's Motoring section, Saturday November 6th 2004, pages 1-2, www.telegraph.co.uk.)*

305) Interference can trigger airbags

Millions of cars have been recalled by the National Highway Traffic Safety Administration (NHTSA) and similar government safety agencies around the world, because of what is known as 'inadvertent air bag deployment'. This includes cars sold by virtually every leading auto manufacturers including BMW, Chrysler, Ford, General Motors, Hyundai, Land Rover, Mazda, Mercedes-Benz, Saab, Toyota, Volvo and Volkswagen.

In addition to rough roads, light jolts, stones bouncing off the road surface and light bender-fender impacts at speeds air bag deployment is unexpected, the reasons for inadvertent air bag deployment include electrical shorts, dirty electrical connections, normal Supplementary Restraint System (SRS) wear and tear, static electricity and an incoming or outgoing cell phone call.

The following incident was reported by a driver in the USA, where cellphones use the PCS system and operate at 1.9GHz: "I was holding the phone at arm's length so I could see the display to dial, in my left hand, so that it was almost touching the centre of the steering wheel when the air bag went off like a bomb. My hand was violently bent over so far that my fingers nearly touched the inside of my forearm. My head was wrenched backwards and to the left like somebody was trying to twist it off my neck. The pain of the air bag hitting my hand was excruciating; it felt like my hand was on fire and went on for what seemed like forever."

The above driver did some investigation, and concludes that: "The thinking is that, in certain circumstances, the electric current coupled into the vehicle wiring from the cell phone antenna when it is close to an air bag igniter can be enough to cause deployment of the air bag. The antenna of my cell phone was, at most, an inch-and-a-half from the centre of the steering wheel when the air bag went off. A US organization involved in EMC testing said that the field at such a small distance from a mobile phone is likely to be in the region of 70V/m."

It is impossible to say with absolute certainty that the cell phone set off the air bag. There are too many unknowns: the exact strength of the 1.9GHz current required to trigger the air bag; the exact distance of the cell phone antenna from the igniter; and the exact strength of RF field emitted from the cell phone's antenna and its coupling factors into the vehicle's wiring. *(Editor's note: But it seems very unlikely that the airbag should operate spuriously at the exact time that the cellphone was close to its igniter.)*

The Automotive EMC Directive requires whole cars sold in Europe to be tested for immunity at a minimum of 30V/m up to 1GHz, in Europe. Since the above cellphone operated at 1.9GHz it is outside the range of this testing and the susceptibility of the car's systems at this frequency is unknown. Also the testing is done with continuous wave (CW) and amplitude modulation (AM), not with the pulsed modulated (PM) signals typical of a mobile phone.

There are no legal immunity requirements for the USA – but all the reputable motorcar manufacturers apply immunity tests anyway to help reduce their risks of liability lawsuits. The EMC immunity specification employed by the manufacturer of the vehicle involved in the above requires electronic 'components' (subassemblies) to pass tests at 200V/m from 1-400MHz in a stripline or TEM cell, and 80V/m from 0-1000MHz in an anechoic chamber. Plus the whole vehicle is tested with radiated external fields at 200V/m from 6-30MHz, 140V/m from 30MHz-1.3GHz, and 70V/m from 1.3-3GHz – but these are the *external* field strengths: the fields inside the vehicle during these tests are not controlled so are unknown (the same comment applies to Automotive EMC Directive immunity testing).

The cell phone concerned operated at 1.9GHz, hence it was outside of the frequency range for the ‘component’ testing range – and the whole vehicle testing might not have created 1.9GHz fields at the steering wheel with field strengths comparable with those created by the close proximity of a cell phone. So neither this particular manufacturer’s tests, nor tests under the Automotive EMC Directive, could be sure to reveal the susceptibility of the airbag igniter to very close proximity of a cell phone transmitting at 1.9GHz. Note that about half of the cell phones in Europe operate at 1.8GHz, using the GSM system, so this brief analysis also applies to them.

(Adapted from information sent in by Martin O’Hara of the Automotive EMC Network www.autoemc.net by email in April 2004.)

306) Cell phones interfere with Lexus sensors

After incidents where cell phone calls apparently interfered with a sensor in some 1998 Lexus GS300 and GS400 sedans, the NHTSA recalled them (No. 98V080): “Due to a manufacturing defect of the yaw rate sensor for the vehicle stability control (VSC), the VSC can operate improperly if the sensor is affected by certain electromagnetic waves, such as from a cellular phone. Should this occur, the brake can operate unexpectedly, affecting steering and speed control, increasing the risk of a vehicle crash.”

(Sent in by Martin O’Hara of the Automotive EMC Network www.autoemc.net by email in April 2004.)

307) Poor power quality makes cooker switch itself on

Typically, regular voltage quality spot checks are made throughout a local distribution system with additional measurements taken when a customer asks; is there a voltage problem? Indeed, this was the initial question that prompted an investigation into the cause of a modern electric cooker switching itself on.

Initial discussions between the local Distribution Network Operator (DNO) and customer revealed that this phenomenon first took place at Easter, then July and was experienced repeatedly throughout the summer months. However, the problem did not then re-occur until late September.

Standard voltage quality analysis – to BS EN 50160 ‘Characteristics of voltage supply in public electric power supply networks’ – simply showed an increased level of flicker, only slightly above normal levels. However, investigations did reveal that a cable-car was located some distance away from the residential area. This cable-car comprised a double lift installation, having a 65kW lift with slipring motor compensated with 20kVAr capacitor power, as well as a 75kW lift with a B6-circuit rectifier drive. Although electrically distant from the local distribution substation, the cable-car was supplied from the substation by a two-core $2\times95mm^2$ copper cable, approximately 400m long.

Further investigations indicated that the oven malfunction seemed to coincide with periods of increased cable car use, normally at peak periods in the summer. A half-day network analysis at the lift equipment connection point in the local distribution system was carried out. Oscillograms were captured when the envelope trigger or transient level trigger varied by 20% of the voltage fundamental peak, or at least 65V between the cable and earth. Results showed that these limits were exceeded by a factor of two, by commutation spikes caused by the operation of the B-6 rectifier drive of the 75kW lift when it was the only lift in use.

Going back to the cooker manufacturer revealed that the cooker’s electronic oven controls initiated switching commands via pulses. It was possible that the commutation spikes – with their steep slopes and zero-crossings – were being mistaken as switch-on commands.

*(Adapted from “*Power Detectives*”, by Stephanie Horton, Engineering Manager at LEM UK Ltd, in the IEE Power Engineer Journal, October/November 2004 Issues, pages 40-41, www.theiet.org.)*

(Editor’s note: Keith Armstrong reports that in private communications with an officer enforcing product safety laws in a mainland European country, the officer said that they had experienced several instances of household appliances turning themselves on by mistake. This includes appliances such as saunas, and fire safety was a significant concern. Interference was regarded as the likely culprit.)

308) Darth Vader toy switched on by low-level interference

What is electromagnetic noise and why is it proclaimed dangerous and unwanted? This extract from Ministry of Commerce's Field Offices newsletter is a graphic example of EM noise and interference (EMI) it may cause. "… A not so long time ago in a distract not so far away, a certain Technical Officer's son received a Darth Vader remote control toy for Christmas. The parents noted that this toy displayed the renowned C-Tick mark for EM Compatibility (EMC)! The children played Star Wars games until the sun set.

And that's when the real story began. You see, once the children were in bed at night, the parents could hear the occasional synthesised sound of "you underestimate the power of the dark side!". A quick check revealed all children asleep and the remote control untouched. Once a number of these occurrences had been heard, an "interference investigation" was launched.

The Technical Officer called himself back on duty and quickly found that the darned toy operated at 27.120 MHz and responded to electrical noise! This EMI could be generated from such simple things as light switches being turned off, and washing machine pumps switching during normal wash cycles…"

(Taken from "The Back Page*" of the EMC Society of Australia's Newsletter, September 2004 Issue Number 27, www.emcsa.org.au.)*

309) Computer company learns that EMC compliance pays

In its formative years, a major US PC manufacturer felt that FCC certification was not a barrier to marketing. Standard operating procedure was to sell while the authorisation process was in process. Then the FCC arrived to shut down the factory. The VP of Engineering met with the FCC in Washington at the last minute and worked out an agreement that kept the factory running. After that point, FCC certification and other agency approvals became a requirement before shipment was authorised. Today, that company has a world class compliance operation and I am proud to have taken part in that process.

(Richard Woods, in a correspondence on the IEEE's emc-pstc list server, 15 July 1998.)

310) Interference before World War 1

The US Military first encountered Radio Frequency Interference (RFI) some time prior to World War 1 when a radio was first installed on a vehicle.

(Warren Kesselman and Herbert Mertel, writing in the "EMC Standards Activities" section of the IEEE EMC Society Newsletter, Summer 2000 Issue, www.ewh.ieee.org/soc/emcs.)

311) New vacuum cleaner crashes car manufacturer's computer

A cleaner in the offices of a major UK car manufacturer started to use a new vacuum cleaner, plugging it into the sockets in a corridor outside the room where their stock control computer lived. Unfortunately, the mains sockets in the corridor were connected to the same branch of the power distribution as the computer, and the conducted noise from the vacuum cleaner crashed the computer. This happened ever day for some time, costing the company a great deal of money, until someone realised the vacuum cleaner was the cause of the problem.

(Anonymous, private conversation August 1994.)

312) Mains transients cause spurious switch-on of toaster, burns gas station down

Transients in the mains supply of a gas station in the USA (called a petrol station in the UK) caused the spurious switch-on a microprocessor-controlled toaster one night after the staff had all gone home. Since the microprocessor wasn't in its normal programme, it didn't switch the toaster off.

The manufacturer of the toaster had omitted to include a thermal fuse, so the gas station caught on fire and burnt down. The PCB had been designed by a UK company, and its designers were later questioned intensely by a team of US lawyers for several hours.

(Anonymous, private conversation, August 1994.)

313) Radar interference anecdotes

Our purchasing manager has a penchant for (expensive) cars. He had a '92 Peugeot 605, and whenever he drove past the military airbase at Lyneham its air bag indicator would light. This was attributed to the site's radar interfering with the car's front wheel sensors. In addition the semi-automatic gearbox would drop into sports mode… The '93 model he now has appears to be immune.

I myself suffered TV interference from ground radar when living 10 miles from Gatwick airport – bars would roll down the screen as the sweep went through.

(From Chris James, private communication, 7th July 1998.)

Banana Skins numbered 314-317 describe interference events that we might not be too surprised to hear about in or after 2015 (shown here in a blue font).

314) 2015: CE does not stand for 'China Export'

A major electronics manufacturer has been ordered to suspend all sales in the EU while it fixes EMI problems with its products. Enforcement officials impounded products in warehouses throughout the EU. The average time to fix a product's EMI problem is expected to be one month, but they have so many products that they expect it will be two years before they finish. They had argued that they thought the CE mark stood for 'China Export', said no-one had actually told them they had to comply with the EMC Directive, and that they were only doing what many of their competitors were doing anyway. The enforcement agents found these arguments unpersuasive.

(Possible electronic industry trade journal news item in 2015, or in fact in any year.)

315) 2015: Plasma beam weapon interferes with COTS

Western military forces have come to rely (unofficially) on the widespread use of consumer ('COTS') electronics such as GPS navigation, cellphones, and palmtop computers with wireless datacomms. Every soldier, sailor or pilot seems to own at least one of each, and they take them everywhere with them, including military exercises and operations. Some enterprising junior officers have even created their own 'command and control' nets, some of which seem to be much more effective than official ones.

But during a recent NATO exercise based around the new SHIVA particle-beam anti-missile tactical battlefield man-pack systems, a large proportion of this COTS equipment failed to work and the unofficial methods that had grown up around them fell apart, causing great confusion. It had not been realised by how much these facilities had come to be relied upon. As a result, the 'attacking' forces easily won the exercise, despite being on foot, armed only with weapons of Afghan war vintage, and communicating by shouting loudly.

(Possible article in Jane's Defence Weekly in 2015, http://jdw.janes.com.)

316) 2015: Vacuum cleaner interferes with space station navigation

A number of people who had been enjoying weightless activities in the non-spinning central hub of Virgin Space Ltd's newest hotel "Arthur C Clarke III" found themselves trapped on the 'ceiling' for 15 minutes, unable to reach the doors that were now 6 metres 'up' a smooth wall. The cause was a new cleaning droid. When it plugged itself into the wall sockets in the corridor in the engineering section a 0.5g acceleration occurred. It was later found that the corridor power sockets were on the same branch of the power bus as the navigation computer, and conducted interference from the new droid caused the asteroid-avoidance emergency thrusters to fire. The droid has refused to comment.

(Possibly from the Sunday Times News Review section, one week in 2015, www.sunday-times.co.uk.)

317) 2015: Intelligent cruise control interferes with latest silicon chips

The 30nm silicon fabrication process is now well-established and helping create many products and provide services that even ten years ago would have been considered science fiction. But investigations by York University into claims of unstable personalities in the latest models of robotic personal companions has revealed that ICs made with 30nm silicon features are very susceptible to the 76GHz radars used by the car-train systems required by automated highway systems. 76GHz automotive radar technology first appeared in the early years of this century as 'intelligent cruise control' or 'automatic emergency braking' systems for luxury vehicles, and is now ubiquitous. York University is now seeking sponsors for a programme of investigation into low-cost techniques for shielding and filtering at 76GHz.

(Possibly from the News section of The EMC Journal in 2015, www.theemcjournal.com.)

318) New battery pack significantly reduces RF immunity of life vest, causes malfunctions

An example of a subtle change in hardware configuration to the original design concept can be found in a life vest. The life vest was fielded with a bridgewire EID that could be fired by a salt-water activated battery pack that had been hardened and certified for HERO. After introduction into the fleet, an engineering change proposal was developed, and approved, to modify the type of battery used in the battery pack. The change was not submitted for HERO consideration. When the life vests were equipped with the new battery pack and used on board Navy ships, there were reports of uncommanded activation of the vests during flight operations and on the flight deck. The subsequent investigation found that the new battery pack made the EID subsystem resonant to a ship radar system; thereby creating susceptibility problems.

*(Taken from MIL-STD-464A, Appendix A.5.9 "*Life cycle, E3 hardness*". 'HERO' stands for Hazards of Electromagnetic Radiation to Ordnance.)*

319) Most ESD test generators do not simulate real-life ESD events

Even though all the (*ESD test*) generators have peak current values and risetimes very similar to the ones specified in the standard, some of the generators fail the equipment under test (EUT) at vastly different voltage levels from the others. A range of 1:5 is shown in the second part of this two-paper series. This indicates that even though all the generators are made in accordance with IEC 61000-4-2 they produce different ESD events leading to a serious repeatability problem when the same EUT is tested with different brand generators. The problems have been well documented although the connection between parameters and EUT failures has been speculative so far.

As the fraction of devices that use fast CMOS is increasing, and going to continue to increase in the future, changes in the ESD standard are needed. Without such changes, the growing fraction of devices that can respond to pulses having widths of tens to hundreds of picoseconds will lead to an increasing dependency of the test result on the model of ESD generator selected.

For an EUT that reacts to the lower frequency (<1GHz) current components, the effect of changing the ESD generator model should not be larger than 1:3. In fact, we have not observed any ratio of EUT failure voltages above 1:2. In contrast, modern CMOS circuits with less than 0.15µm technology can react to pulses as narrow as 50ps. These circuits will respond to the fast-changing (unintended) components of the induced voltage. The effect (*on such fast devices – Editor*) of changing the ESD generator model may be as large as 1:10, as the spectral density varies by more than 20dB, as shown in our Fig. 3. Our observations showed a 1:5 variation.

With the introduction of more and faster CMOS circuits, the large influence of the ESD generator model, shown in Fig. 4, will occur more often if the ESD standard is not improved.

How many of the ESDs will have a larger severity than the reference event? Due to the strong dependence on factors like humidity, personal activity, clothing, etc, there is no final answer. Generally, for lower voltages the typical rise times are much shorter and the rate of occurrence of ESD is larger, but fast rising ESD having less than 300ps rise time can also occur under dry conditions and fast approach speeds at voltages as high as 15kV.

These low-voltage ESDs and higher voltage ESDs having short arc-lengths show short rise times, as low as 50ps, thus their high-frequency content is much stronger. Up to now some widely used ESD generators not only covered the spectral content of the proposed reference event, but also tested for fast rising ESDs. They did not do so intentionally, but as a result of their design, which was based on incomplete understanding of the failure mechanisms in fast electronic systems and insufficient specifications.

In our opinion, the ESD standards IEC 61000-4-2 should be revised such that ESD generator performance is as similar to the reference events as possible in all their parameters. But manufacturers and users need to be aware that the standard does not cover all possible ESD events. For example, medical equipment might need to be tested using a shorter rise time to cover a larger portion of the real ESDs, notwithstanding furniture ESD or other ESD types. The standard needs to be understood as a minimum requirement, passing it does not protect against ESD related field failures.

*(The above are some paragraphs taken from "*Characterization of Human Metal ESD Reference Discharge Event and Correlation of Generator Parameters to Failure Levels — Part I: Reference Event*" and "*— Part II: Correlation of Generator Parameters to Failure Levels*" by K Wang, D Pommerneke, R Chundru, T Van Doren, F P Centola, and J S Huang, IEEE Transactions on EMC Vol. 46 No. 4 November 2004, pages 498-511.)*

320) Phone masts interfere with car immobilisers and alarms

Customers at two garages in Birmingham are reportedly being forced to freewheel their cars off the forecourt. 'National Tyres' and 'Car Spares', both on the city's Stratford Road, are experiencing interference from phone masts on the roof of the Centre Court office block and visitors to the sites have to push their cars nearly 100 yards out of range of the masts before starting them.

Clive Carter, from National Tyres garage, and Keith Murphy, from Car Spares, told the Birmingham Post that many customers could not start their vehicles in their forecourts. It is believed the mast's rays are interfering with car's ignition systems, immobilisers and alarms. Mr Carter said: "This has happened at least 20 times in the last year. The strange thing is that when a car is pushed down the road it starts easily. The mobile phone masts seem to be the only explanation for it."

(Taken from the HSE's internal newsletter, 7/3/05, sent in by Simon Brown)

322) Electromagnetic pulse gun stops speeding cars at 50 metres

A hi-tech device that can bring speeding cars to a halt at the flick of a switch is set to become the latest weapon in the fight against crime. Police forces in Britain and the US have ordered tests of the new system that delivers a blast of radio waves powerful enough to knock out vital engine electronics, making the targeted vehicle stall and slowly come to a stop.

David Giri, who left his position as a physics professor at the University of California in Berkeley to set up a company called ProTech, is developing a radio wave vehicle-stopping system for the US marine corps and the Los Angeles police department. Tomorrow, at the Euroem 2004 science conference in Germany, Dr Giri will describe recent trials of the device. The tests proved that the system could stop vehicles from up to 50 metres away.

The bulk of the device is designed to fit in a car boot and consists of a battery and a bank of capacitors that can store an electrical charge. Flicking a switch on the dashboard sends a burst of electricity into an antenna mounted on the roof of the car. The antenna then produces a narrow beam of intense radio waves that is directed at the vehicle ahead. When the radio waves hit the targeted car, they induce surges of electricity in its electronics, upsetting the fuel injection and engine firing signals. "It works on most cars built in the past 10 years, because their engines are controlled by computer chips," said Dr Giri. "If we can disrupt the computer, we can stop the car." A prototype is due to be ready by next summer.

The Association of Chief Police Officers confirmed that researchers at the Home Office's police scientific development branch are testing a radio wave vehicle-stopping system. "There's a potential to use this type of device to stop criminals on the road. High speed pursuits are very dangerous, especially in built-up areas," said an association spokesman.

*(From "*Police test hi-tech zapper that could end car chases*", Ian Sample, science correspondent, Monday July 12, 2004Guardian Unlimited © Guardian Newspapers Limited 2004.)*

323) Domestic switching transients interfere significantly with some DAB radio receivers

Browsing through EMC & Compliance Journal today I am reminded of a very obvious form of RFI generated at home. We are all aware of TVs and radios being effected by vacuum cleaners, food mixers, mobile phones and the like (and some cars, but far fewer these days), but a more specific form of interference has exhibited itself ever since I was given a DAB radio for Xmas by my better half.

When switching low-energy bulbs on or off in the vicinity of the radio (but as far as 5m away) reception is, as often as not, completely halted for a second or so, a much more 'catastrophic' event than the usual crackle from conventional AM/FM radios. Such is the price of progress!

(Sent in by Dave Bethell, Principal Engineer, Anthony Best Dynamics Ltd, 12th January 2005.)

324) Self-inflicted EMC problems in the military

Banana Skin number 6 refers to EMC problems during Desert Shield and Desert Storm. EMC problems can be self inflicted; I remember seeing a radio-listener's report on a USENET forum that tactical inter-plane chatter was heard in the US on the US Navy UHF satellite outputs, apparently from aircraft in the initial attack waves of Desert Storm. This seems to have been due to frequency coordinators unknowingly assigning attack frequencies in the satellite uplink range.

(Sent in by Cortland Richmond, KA5S, May 21 2005.)

325) Small brushless DC motor interferes with microwave comms link

We had a receiver noise problem with a 'C' Band SNG van when the dish was pointing near the horizon (over the air con unit). We were getting random loss of signal (broadcasters NOT happy!). Investigation (with a spectrum analyser probe near the motor body) revealed that the (DC brushless) fan for the air-con unit was radiating a strong comb spectrum from the 150KHz-ish of it's SMPSU up to over 6GHz and a reduced level was still detectable at 14GHz! It seems that the (CE marked!) motor of Italian manufacture (used extensively for vehicle radiator cooling as well as in air-con units) recently had it's die-cast motor end plate changed to a plastic moulding (plus perhaps newer faster switching transistors?). The un-shielded motor/electronics was therefore radiating quite strongly.

Our solution was to fit a metal disc/plate over the motor hub (a screen between the source and our 1.2M dish antenna). This effected about a 20dB improvement and enabled the system to work as intended (signal now above rather than below the interference!). I suspect that if any EMC testing was performed, the type of product would suggest that only conducted and power clamp measurements should be performed and NO radiated emissions (certainly not above 1GHz). After all a DC motor cannot cause many problems can it????

Unfortunately it seems even small low power internal air circulating fans of the brushless DC type produce quite heavy conducted and some radiated RF. Some of our products have had problems with fan EMC within a unit. We now, as a matter of course tightly twist the wires and sometimes add a common mode choke to the fan feed to avoid noise on the 5V, or 12V rails corrupting signals and data within our broadcast encoders etc.

(Sent in by Dave Keston, Approvals Engineer, Vislink Communications, 20th January 2005.)

326) TV antenna boosters the cause of interference from new radio service

The new emergency services radio system, called Airwave, has been blamed for interfering with television reception, but where problems occur the fault lies with the filters on domestic aerial amplifiers. Trade and Industry minister Steven Timms, in a Parliamentary written answer, said: "Ofcom is aware of instances of interference to domestic installations from Airwave radio base stations. In all the instances so far investigated the consumer's own masthead aerial amplifier, used to boost weak signals, has had a pass-band wide enough to boost the television signal and, inadvertently, the unwanted radiocommunications signal."

Airwave is being rolled out across the Great Britain for police and public safety communications, with completion due by 2005, when existing frequencies will be withdrawn. It is a digital system based on the ETSI-approved Tetra (Terrestrial Trunked Radio) standard. Mr Timms went on: "Testing has shown that the Tetra transmitters were operating correctly and within their designated licence parameters. In most cases a suitable filter fitted between the masthead amplifier and the TV aerial will resolve the interference, and affected residents have been advised to have such filters fitted. As a goodwill gesture Airwave has arranged for filters to be fitted to the affected television installations in certain circumstances."

*(“*Aerial amplifiers cause Tetra TV interference*”, from ‘EMC Industry News 2004-01-15’ on the IEE’s EMC Professional Network website, 18th Jan 04, www.theiet.org.)*

327) Mobile phones interfere with railway signalling and ticketing

In south Jutland, the Danish state railways, DSB, have forbidden mobile phones on all marshalling yards in the district. The reason is that GSM telephones have caused the signal system to switch from green to red, and have also caused interference in the ticketing system used.

(Sent in by John Whaley, 16th May 2005)

328) Wi-Fi hotspots interfere with military radars

Northwest Florida Daily News reported that Air Force officials say high speed and wireless internet connections are interfering with their tracking radar at Eglin Air Force Base, Fla. The radar is a vital tracking tool for high-tech weapons over the Gulf of Mexico. They notified Okaloosa County officials, who responded by warning that if the interference were intentional, violators would be fined and their equipment confiscated. The troubled frequency band is in the 5.6 GHz to 5.8 GHz range.

"There are evidently people who are firing up (wireless Internet) hot spots without (Federal Communications Commission) licensing," County Manager Chris Holley said. He said Air Force officials told him the interference is infrequent but that they hope to stop the trouble before it becomes widespread.

*(Taken from the "*From the Grapevine*" section of the Joint E3 Bulletin, Volume 11, Issue 2, April 2005, A Publication of the U.S.A. Department of Defense. The article was originally called "*High Speed Net, Wi-Fi Interfering with Military Radar*" and was sent in by Terry Dunford of the CAA, www.caa.co.uk. Terry would like to point out that in the UK, meteorological radars work on 5.6GHz.")*

329) Many WLAN products returned to stores due to interference

Interest in using smart antennas in Wireless LAN (WLAN) and mobile networks is gathering pace, according to Tim Berghuis of US-based InterDigital Communications. Mr. Berghuis, who was demonstrating the company's AIM (adaptive interference management) antenna at the recent 3 GHz Global System for Mobile (GSM) World Congress. He stated that, "On the WLAN side there's been lots of interest; and we're seeing quite a bit of interest on the mobility side - both GSM and Code-Division Multiple Access (CDMA) 2000."

Berghuis noted that the "bigger problem" lies with WLAN, which accounts for approximately 25 percent of the products returned to stores because customers cannot get them to work. Berghuis said, "People hook it up and it's not working and we think a good portion of this is attributable to interference."

(Taken from the 'From the Grapevine' section *of the 'Joint E3 Bulletin', Volume 11, Issue 2, April 2005, A Publication of the U.S.A. Department of Defense. The article was originally called "3GSM: Interest rises in Smart Antennas" and was sent in by Terry Dunford of the CAA.)*

330) Vatican radio operators prosecuted

In a follow-up to a long running story, sources throughout Europe are reporting that an Italian court has convicted a Roman Catholic priest and a cardinal of polluting the atmosphere with powerful electromagnetic waves. Cardinal Roberto Tucci and Father Pasquale Borgomeo were given 10-day suspended jail sentences and ordered to pay damages and court costs. Earlier two scientific studies had suggested that the cluster of powerful broadcast towers north of Rome could be responsible for the high cancer rates in the area.

Earlier court actions were thrown out because of a now over-turned ruling that Italian courts had no jurisdiction over the Vatican, which is a separate sovereign state. Vatican Radio Program Director, the Reverend Frederico Lombardi, vowed to appeal.

*(Taken from the 'EMC News' section of Interference Technology's on-line EMC newsletter, May 18 2005, http://www.interferencetechnology.com. A similar story "*Vatican Radio officials convicted*" appears in the BBC News at: http://news.bbc.co.uk/go/pr/fr/-/1/hi/world/europe/4531247.stm, published 2005/05/09 20:43:52 GMT.)*

331) VCR/CD/DVC combo TV sends out false distress signals

This October, Chris van Rossman of Corvallis Oregon turned on his do-everything combo TV and got a big surprise—the police, the Civil Air Patrol, and the County Search and Rescue Officers knocked on his door. Apparently, Mr. van Rossman's flat screen, VCR/CD/DVC combo TV had developed some sort of strong emission (a parasitic oscillation, more than likely) at 121.5 MHz, which is a rescue frequency used by aircraft and boat distress transponders and monitored by orbiting satellites. This service uses an uncoded analog carrier detection system, and is therefore rather sensitive to unauthorized transmissions.

When the distress signal was picked up from the satellite, the information was picked up by the Air Force Coordination Center at Langley Air Force Base in Virginia. Langley in turn called the volunteer Civil Air Patrol in Oregon, which in turn contacted Benton Country Search and Rescue for help in locating the signal. Using radio direction finding equipment, the officers were able to narrow the source down to a few possible units in Mr. Rossman's apartment building. When they knocked on his door and he turned off his set to answer, the signal disappeared.

David Mandrell, the CAP squad leader had heard of similar inadvertent interference from consumer equipment, but often it was weak enough to be ignored. This particular instance of interference was unusual because it was abnormally strong. Mr. Rossman was simply warned to keep his TV turned off or face fines of potentially up to $10,000 per day for emitting a false distress signal. He has contacted the set's manufacturer, whose technicians had never heard of a case like this, and has agreed to send him a free replacement.

(Taken from Conformity magazine, Jan 21 2005, *http://www.conformity.com, the original article was entitled: "*TV Interference Triggers Aircraft Rescue Satellite Response*", and published in the Corvallis Gazette-Times, Oct. 17, 2004)*

332) **Illegal truck radio transmitters suspected of causing two bus accidents**

It has been reported widely in the Japanese press that electromagnetic interference caused by illegally modified transceivers on trucks is suspected of causing two accidents by disabling the braking system of commuter buses. Mitsubishi Fuso Truck & Bus Corporation announced that two models of its buses are adversely affected by high-powered EMI from short distance and its braking system may not function properly under such conditions. Specifically, its braking system that detects the wheel-locking condition falsely triggers due to the EMI and thus the brake doesn't work as intended.

Two accidents were reported last year where the bus drivers reported that the brakes suddenly stopped working. However, after the police investigation, no visible malfunction was found. The manufacturer continued investigation and found that high-powered radio signals emitted by a nearby transceiver (illegally modified and thus 1,000-10,000 as strong as permitted by law for such transceivers) can interfere with its braking control unit, resulting in false information that the wheels locked due to braking. Upon this false information, it seems (my interpretation from what I read various reports) that the control unit decided to release the brakes, and thus caused unintended loss of braking.

It is not known whether such illegally modified transceivers were present nearby in two accident cases. But in other two instances where loss of braking was observed, the bus drivers saw suspicious trucks nearby. The company could reproduce the condition in live experiments, and it will refit the 2200+ cars by replacing the control unit, sensors, pipes, circuit harness, etc. I think the company should be commended for its continued investigation after the accidents.

*(An extract from the Risks Digest 5 Jan 04 issue that is posted at: http://catless.ncl.ac.uk/Risks/23.09.html. Sent in by Simon Brown of the HSE, January 2003. The Risks Digest describes itself as a "*Forum on Risks to the Public in Computers and Related Systems*", current issues can be read at: http://www.csl.sri.com/users/risko/risks.txt.)*

333) **Concerns about worsening interference in medical and healthcare discussed**

Is there enough regulation in the EU to avoid the potentially fatal outcomes for patients that could occur when electromedical or electronic medical devices interfere with each other or with other equipment? And are manufacturers taking enough care to ensure that they are not exposing themselves to the litigious consequences of being negligent in ensuring that such devices operate properly in the environment for which they are intended?

Those were the questions being asked on June 15 in London at the Management Forum Regulatory Update for Electromedical Device and Equipment Manufacturers in London. While actual cases of serious incidents and deaths caused by such interference are difficult to establish given the anecdotal nature of many reports, a UK study dating back to 1993, suggested there had been 23 serious incidents and two fatalities due to electromagnetic interference that year.

Unfortunately, more recent events are "hard to nail down" one regulator told the meeting, although "we know there are causes and effects, and with basic proximity testing you can prove this". Hospitals are generally reluctant to report incidents, delegates at the meeting heard, because of the fear of blame, as was the case when one surgeon answered his mobile phone in the operating theatre, causing the anaesthesia machine to reset.

Without doubt, potential interference is a growing problem and, unless something is done to keep up with the rapidly changing technological environment, manufacturers are going to find themselves increasingly at risk of being accused of lack of due diligence and even negligence.

Consultant Trevor Lewis of Medical Device Consultancy told the meeting: "We know that there is a lot [of interference] going on. Whether it is being reported is another matter. To get more people to report we should avoid apportioning blame and that may move forward the trend to report."

Mr Lewis is adamant that something needs to be done and quickly on an EU level. "I've seen this trend [of electromagnetic interference] moving forward, and I want to be able to advise my clients accordingly to make sure that they are robust from a regulatory and liability point of view," he said.

This not an issue that manufacturers can solve on their own, he insisted, since about 85% of companies operating in this area are small firms and simply cannot afford the resources to analyse the environments in hospitals into which their equipment is placed. Instead, Mr Lewis believes "it would be good if the regulators could characterise safe environments - not only in hospitals, but in homes as well".

To what extent the hospital managers are also responsible for ensuring that electromedical and electronic medical equipment is used in situations where the risk of interference is avoided, seemed unclear at the meeting.

"Very few NHS hospitals are taking this seriously," Chris Marshman, managing director of York EMC Services and chairman of the conference said. Most hospitals, he continued, have medical physics departments that would be capable of the necessary assessments yet it "seems nothing is happening and there is no co-ordination".

It is not only the decisions about where to install products that need to be taken by those in hospitals with a full understanding of the potential interference problem, it is also decisions concerning the management of the maintenance of equipment. Some clinical engineers working on equipment in accident and emergency, for example, may be unaware that if they remove the screws from an item of equipment during maintenance and then fail to put them all back, that this could change the EMC of the equipment and potentially increase risks.

So with all the risks bound up in the use of electromedical and electronic equipment, what can manufacturers do to ensure to prove that they have taken all reasonable steps in terms of addressing issues that arise through a constant risk analysis and management to avoid the risk of interference?

The key here for manufacturers is to ensure instructions for use are clear and readily available, to provide a good installation guide to ensure that the user can safety install the equipment and to use historic good practice to give indications about the careful "zoning" of equipment in the intended environment to avoid interference problems, Mr Marshman said. Also necessary is any further information that will ensure the device is EMC compliant throughout its lifetime, including flagging up in the maintenance file any essential steps, such as putting back all the screws on equipment and explaining why.

"Care is needed on both sides," Mr Marshman insisted. "The manufacturer with the instructions, and users to make sure that they know what they are doing...The duty on users is to make sure that they are doing the best they can."

Finally, a word of warning was given by Ian Cutler, senior medical devices expert and European regulatory affairs consultant to the medical devices industry. Mr Cutler reminded delegates that the healthcare environment is becoming increasingly litigious and asked the meeting to imagine what a prosecuting lawyer would ask, should an incident lead to court action. "Did you consider how X could have had an effect on your product? And, did you have enough technical data to justify your claims on performance?" would be among the likely questions and companies would be found to be totally negligent to ignore potential new sources of interference.

So, it is clear that companies operating in this sector expose themselves to being prosecution unless they are constantly updating their knowledge of potential and changing risks and applying it to products being marketed and in the field. Unless manufacturers perform constant post-market surveillance and risk management and act immediately on their findings, they could face sanctions, including criminal prosecution.

(Taken from "Is the EU underplaying the device interference problem?", Clinica – World Medical Device & Diagnostic News: Issue 1113, p8 , filed 21 June 2004. Trevor Lewis can be contacted at: lewlink@btclick.com)

334) BMW screen heater interferes with car radio

Q: The rear-screen heater in my BMW 3-Series causes so much interference when switched on that it's impossible to listen to the car radio. Our local BMW dealer suggested replacing the entire rear screen as at cost of more than £600. This seems drastic. — KR from Hertfordshire.

A: This is a known problem within the trade. It stems from the fact that the rear screen includes both the heating elements and the radio aerial. The high level of electrical current required by the heating elements is being picked up by the aerial. Fortunately, it is usually possible to fit one or more electrical suppressors into the heated rear window wiring, as close as possible to the window itself. These reduce the electromagnetic interference from the screen to a level where it shouldn't interfere with the aerial. This will cost much less than a new screen.

(Taken from 'Car Clinic', Sunday Times, March 13 2005, page 26, www.sunday-times.co.uk.)

335) EMI suspected of causing cancellation of shuttle launch

Just in case anyone in the EMC community was away from the media for the last few days, electromagnetic interference is one of the suspected culprits in a fuel sensor malfunction that resulted in the cancellation of the first planned space shuttle launch earlier this month. Four hydrogen fuel sensors read either wet or dry, and a dry reading from all four sensors triggers engine cutoff and an aborted launch. After the originally scheduled flight was called off on July 13, literally hundreds of engineers tried to recreate the electromagnetic environment in which one sensor failed intermittently. Reportedly grounding was improved, and the entire craft re-examined for possible sources of EMI.

Still, the exact cause of the intermittent failure was not identified, and NASA rules were modified so that lift-off could take place with three operational sensors. Fortunately, the intermittent fuel gauge glitch did not reoccur during Tuesday's lift-off. (Sadly, as we prepare our final copy, word of foam problems and cancellation of future flights has just been released to the media.) Clearly, NASA personnel face some daunting challenges in the months ahead. Moreover, every modification to the extremely complex craft alters the EM environment in which delicate instrumentation must function.

(From Interference Technology E-News, 29 July 05, http://www.interferencetechnology.com.)

336) Close proximity of cell phone corrupts data in keyfob, immobilising vehicle

I've always been suspicious of admonitions to turn off mobile phones on planes, in hospitals and so on, believing them to be yet more examples of the culture of bossiness that pervades modern life. It turns out that the bossy-boots are right.

You know how it is – one minute the car is working perfectly; the next – literally – it has conked. So it was last weekend when I was trying to transport four extremely heavy lead planters, overlooked by the removers, from the old flat to the new house. Various people emerged to have a look and offer advice, including the mechanic who lives opposite (who said Londoners aren't neighbourly?), but the nature of the conking-out remained a mystery. “It sounds as if it is trying to start, but isn't.” said one man, helpfully (who said men know all about cars?).

Then the AA man arrived – all yellow van and flashing lights, just like in the adverts – and solved the problem immediately. Had I, he asked, kept the car key anywhere near my mobile phone? Well, of course I had. Like most women I lug around a miniature version of my life in my handbag.

This was my mistake. The mobile phone signal had corrupted the chip in the key, disrupting the central locking system and knocking out the ignition. The thing was that none of us knew about this – not me, the neighbours, friends I have told about it, not even the mechanic. I pass on the information so that no one else finds herself stuck on a yellow line in the middle of London on a searingly hot day with a car that is going nowhere.

(From Rachel Simhon's column in the 'Diary' section of the Daily Telegraph, Saturday July 16 2005, page 23.)

337) Modern EM environment creates problems for audio induction loops - examples

Being involved in providing audio induction loops for hearing aid users, I am interested in cases of audio magnetic interference. The modern electromagnetic environment has an increasing number of these.

While installing loop systems in a building in Wolverhampton Science Park I checked for possible interference. A coil of red-coated pyrotenax cable in the ceiling was interesting. That being part of the Fire Alarm installation, I used the monitor receiver to listen to the “Break-Glass” alarm point. Again, I heard the same digital noise right across the audio range. This kind of interference is a continuous background buzz for hearing aid users wanting to use an induction loop. This compares with listening to a car radio, or to a CD with a noisy fan in the room. In practice, the magnetic field from the Break-Glass would not be a problem. But the field from the cable routing and the coil of surplus cable just above someone's head could be.

We found a similar interference in a new building in Edgbaston High School. Most of the hall is clean, but there is one corner with significant digital noise. Again, it happens to be next to a storeroom containing the displays for the fire alarms. Otherwise, in that room, the fire alarm is cleaner than at Wolverhampton.

A case which may not be an audio magnetic field (I did not have the right detector available) was at my mother-in-law's. We heard that the Hi-Fi had developed a fault, and there was a buzz. I found this buzz on the cassette deck, though the radio was clean. Moving the BT DECT cordless phone cured the problem. The wiring for this, from the power supply as well as the phone line, seems to be the main radiator. Since it is plugged in to the same mains point as the hi-fi, separating the items is difficult. It is not clear whether or not this is magnetic interference. But cassette tape play heads are susceptible to magnetic fields. For example, with separate items, placing a tape player on top of an amplifier usually causes a loud hum from magnetic coupling to the amplifier power supply.

Audio induction loops are a common "aid for the disabled" using the audio magnetic spectrum coupling to a pick-up coil in the hearing aid. The target magnetic field is 100mA/m to match normal hearing aid microphone levels. Installers, and public buildings, use monitor receivers to check loop systems. One such monitor is the Ampetronic ILR2 which allows people with normal hearing to hear what a hearing aid user would hear.

I happened to have a loop monitor with me when I was shown around the brand-new library building in Bournemouth. They have the, now ubiquitous, standard screening arrangement to detect books being smuggled past the check-out. This generates such a strong magnetic field that the nearest induction loop on the counter has to be about 4 metres away. Any closer and the noise, a constant whistle at about 1kHz or so, is intolerable for hearing aid users.

Similar anti-theft screens, the familiar pair of (usually) grey loops you walk between entering or leaving larger shops are very common. Because check-outs are near the doors, this is likely to be a problem where hearing aid loop systems are fitted. I happened to visit a major car accessory shop in Birmingham, again with a loop monitor to hand. The whistle from the security screen could be heard out in the car park.

(*Sent in by Robert Higginson, 14 July 2005*)

338) Audio induction loops can interfere with other equipment

Audio frequency induction loops are an aid for hearing aid users which generate an audio frequency magnetic field. Often the siting of these is very restricted because of the way a building is built. While there is a specification for the field strength, this applies to normal listening position and there can be very high fields close to the loop cable. These fields can couple into other systems and equipment. Because EMC specifications are geared up for radio frequencies or mains power, high levels of audio magnetic fields are often forgotten.

We installed a desk loop system at an enquiries desk. These are supplied as kits, with a pre-formed loop coil usually located just underneath the desk, and driven hard so that the hearing aid picks up the spill field rather than the main field inside the coil. Having set the field to give the required "head height" signal, we found that the computer was responding to the magnetic field. The keyboard had a magnetic card reader used for staff to log-on. This was interpreting the audio signal as an erroneous user-name and password. Options were limited as there was only one tidy and vandal resistant place to put the loop. The solution was to move the keyboard away from the loop installation. In its normal place, the keyboard would be exposed to magnetic fields of several amps per metre.

Several years ago we installed a sound amplification system including induction loop in a church building. They also had a video projector, used with computers and video players with no problem. Recently they bought a new lap-top computer and the supplier offered a special package deal including a new projector. The new equipment picked up "hum bars" from the loop. The computer firm, apart from comments about "new regulations for loop installations" proposed the loop amplifier being switched off. We tried a range of other projectors and there was no problem. Only the Hitachi projector supplied packaged with the computer suffered hum bars. As an isolated equipment, a projector may pass susceptibility tests. But such equipment is never used in isolation, only as part of a system.

(*Also sent in by Robert Higginson, 14 July 2005. Also see Robert's article "*Are You Hearing Me? An aid for the disabled lacking EMC protection*" in the UK EMC Journal, June 1998, pp 14-16, available from the archives at http://www.compliance-club.com.)*

(The Editor notes that the immunity standard for professional audio, video and lighting equipment and systems, EN 55103-2, includes requirements for immunity testing with audio-frequency magnetic fields. But system integrators often use 'domestic' equipment that has not been made compliant with EN 55103-2, in their systems, and ignore their responsibilities under the EMC Directive by assuming that simply using CE marked items of equipment will result in a compliant system – the so-called CE + CE = CE approach, which does not work and furthermore has no legal or technical justification.)

339) Plasma screens in waiting rooms interfere with ultrasound medical diagnostics

A new hospital, commissioned in 2002, had large plasma display screens in their waiting rooms, showing fish swimming. But ultrasound diagnosis equipment in the rooms on the other side of the walls that the plasma displays were hung on suffered from interference. Close-field probing with a spectrum analyser showed significant levels of emissions leaking through the wall from the waiting room plasma displays, so they were assumed to be the culprits.

Moving the ultrasound equipment to the far side of the room from the wall shared with the waiting room reduced the level of the interference. When the interference levels are too high for a particular test, the ultrasound operators have permissions to switch the plasma displays off.

(*Sent in by Clive Griffiths, 15th June 2005*)

340) Wireless devices interfere with office equipment in U.S.

USA delegate opened a discussion on the new work being promulgated in the US by ANSI to address immunity concerns from wireless devices when used in close proximity to office equipment. (This had originally been raised by Goldman-Sachs who found this problem in their offices). The primary concern appears to be interference to telephone devices, although the draft ANSI standard is not limited to them alone. The standard being developed appears to be a product standard, not a basic standard. There is no chance of this being legislative but likely to remain a contractual issue.

This is a cause for concern to WG10 because of the risk of alternative test methods and attendant problems of multiple test regimes, inter-correlation, etc. It appears that this work has come about because of the lack of any immunity requirements in the US *(for household, commercial and industrial products – Editor)*. Similar environments in Europe where CE marking is required have not evidenced such susceptibility.

(A report from a delegate to the WG10 Meeting 25-29 April 2005, Beijing, China, "Maintenance of 61000-4-3").

341) Lighting system capacitors cause power system resonance hence failure of crane motor

Haag cite one experience where an intermittent failure was caused when the pulse driven motor of a crane went into resonance with the compensating capacitors of a nearby lighting system. It was interesting to note that because those involved were not familiar with the possibility of such mains linked resonances, all manner of costly time-wasting investigations were carried out and sources of blame sought, before the real culprit was found.

*(From "*Does your system have 50Hz impedance myopia*", Ron Neale, EMC Engineering Europe, March 1998, page 5.)*

342) Problems of excessive recovery times following mains interruptions

The point of the voltage interruptions tests in EN 61000-4-11, and the generic and product immunity standards that call them up, is that equipment should recover from such events as if nothing had happened, or at least as if they had just been switched on for the first time. Even for older equipment that pre-dated the above immunity standards, interruptions in the mains power is a rather obvious fact of life and designers could be expected to have designed accordingly. But recently I had to service a modified (and expensive) CD player that had some special system for background music.

There had been a 10-second-long power cut in Northampton, where it was installed, and the thing would not come back to life afterwards. Actually, it was not working when I collected it, but started working the next day (presumably after some capacitor had sufficiently discharged).

That 10-second power cut also put the Northampton traffic light system out of operation for a long time – increasing safety risks at road junctions. While working in the All Saints area of West Bromwich, we noticed several brief power cuts, the longest being perhaps only one second, and these appeared to put the traffic lights out of action for a lengthy period of time.

(Sent in by Robert Higginson, 13 September 05.)

343) Spectrum reallocation to reduce interference with emergency services radiocomms

26 January 2005: Philadelphia FOP Wants Radios Replaced; failures characterized as possible life-or-death issue. In a follow-up to a story reported earlier on InterferenceTechnology.com, major news outlets in the Philadelphia metropolitan area report that the head of the city's Fraternal Order of Police (FOP) has called on city officials to replace the two-and-a-half year old Motorola police radio system because of repeated communications failures. A report from an independent consulting firm hired by the city cited possible interference from wireless telecoms Nextel Communications and Cingular

Wireless. City officials expressed reluctance to scrap the $52 million dollar system and expressed hope that the FCC's proposed spectrum-swap for Nextel would help alleviate the problem. Meanwhile, FOP officials warned that their next press conference could bring very tragic and sobering news if the problems go uncorrected. For the FOP position on this issue, go to http://www.fop5.org/.

11 February 2005: Nextel, FCC Agree to Spectrum Swap to Solve Long-Standing Interference Issues. In an historic agreement, Nextel Communications will receive a new swath of spectrum from the FCC in exchange for ceding its former spectrum in the 800-MHz band. Nextel will also pay to reconfigure the airwaves it currently occupies. Presumably, this pact will put an end to the complaints from numerous public safety agencies that Nextel's signals interfere with and sometimes drown out vital police and fire radio communications. The agreement was announced by FCC Chairman Michael Powell and Nextel President Tim Donohue. Powell hailed the solution to a problem that he termed, "difficult, complex, and challenging." Donohue characterized the resolution as, "simply the right thing to do for first responders, homeland security, and for Nextel."

Specifically, Nextel will move its remaining spectrum in the 800-MHz band, bundle it together, and move it further away from the airwaves used for public safety broadcasts. The public safety broadcasters will be located next to each other within the band. Nextel will also receive new spectrum in the 1.9-GHz band, where other major wireless telecoms are located. The new spectrum is valued at $4.8 billion, which Nextel must pay the FCC; but the telecom will receive a $2 billion credit for the spectrum it is returning. Nextel will also receive a credit for the relocation costs it incurs; these costs have been estimated at $1.3 billion. The transition is to begin immediately and should be completed in about three years. For the official announcement, go to www.fcc.gov.

(From Interference Technology E-News, 26 January 2005 and 11 February 2005, http://www.interferencetechnology.com. For the background to this issue see Banana Skin No. 281.)

344) 'Broadband over power line' (PLC) will interfere with radio astronomy

Sharing studies between the radio astronomy telescopes and the power line communication systems in the HF region. Internet: http://www.qsl.net/jh5esm/PLC/isplc2003/isplc2003a7-4.pdf. Summary: Radio Astronomy has frequency allocations in 13.36-13.41 MHz and 25.55-25.67 MHz on a primary basis worldwide. These bands are extensively used by radio astronomers to observe electromagnetic waves emitted by the Sun, the Jupiter and other large, gaseous planets in the solar system. The powers from a single Power Line Communication (PLC) system in the above radio astronomy bands are -33 dBW and -29.2 dBW respectively and therefore the PLC systems seem to be a harmful interference source for the radio astronomical observation in the HF band.

It is necessary to keep an adequate separation distance to avoid harmful interference to the radio astronomy telescope, and we calculated the separation distance based on the free-propagation method. We obtained a value of 424 km. If the PLC system is widely deployed, it is sure that the interference level increase greatly and the separation distance will become much larger. Thus it was recognized that it is quite difficult to share frequencies with the PLC systems and radio astronomy telescopes, at least, in Japan, and that a new technology to dramatically reduce leaked emissions from the power lines are crucial for the PLC systems to coexist with other radiocommunications services. Authors: by M.Ohishi, J.Nakajima and M.Tokumaru

(The above was extracted from: http://www.arrl.org/tis/info/HTML/plc, June 2003, which has 24 pages of information and links on PLC/PLT, also sometimes called broadband over power line (BPL). Concerned radio astronomers should also see Banana Skin No. 272.)

345) Interference from lighting is an ever-increasing threat

Standard CISPR15 (EN 55015) is a special product family standard for electrical lighting and similar equipment that has served the market well for many years, but in recent times the incidence of interference from lighting has increased [1]. This has coincided with technological developments in the lighting industry [2]. With the increasing pressure for more energy efficient lighting [3] and because of requirements for more energy labeling of household lamps [4], there will be an increase in the use of technologically advanced lighting. This is the reason, why CISPR15 has been seen to be insufficient and it is under revision.

Unlike the generic standards and most other product family standards, CISPR15:2000 contains no requirements for radiated emissions from 30MHz to 1GHz. Also in Finland, it has been found that some lighting appliances are causing harmful interference to radio communications on the VHF band.

Therefore these lamps and luminaires are not in compliance with the EMC Directive (EMCD), although they might fulfil the requirements of CISPR15.

Energy saving lamps (ESLs) are typical sources of interference to TV VHF broadcast receivers and also to private radiotelephone networks on the VHF band [2], [1]. Finnish EMC market surveillance authorities , the Safety Technology Authority (TUKES) and the Finish Communications Regulatory Authority (FICORA) have received several interference complaints concerning ESL bulbs. In 2003, FICORA solved ten interference cases caused by ESLs. It is likely that these kinds of interference cases will increase in future. Fig. 1 shows the measurement results from an ESL that was intended to be used in a new conference hall in Tampere, Finland. These kinds of lamps were installed throughout the building. Radiated interference from these lamps was so high that it was not possible to use VHF radiotelephones inside. All ESLs were then replaced. The bandwidth of the interference was about 50MHz (-30 dBc points) and the interference occurred on the frequency band 159 – 209 MHz. In Finland, this band is sued by many different radio services including emergency services (police, fire brigade, ambulance services, etc.).

TUKES has also received other complaints concerning interference cases caused by ESLs. Typical equipment being disturbed has been, for example, the remote control of TVs or narrow band in-house telecommunication networks using domestic 50Hz/230V electricity mains wiring. The disturbances between TVs and their remote control equipment was mostly caused on the infrared band, for which there are no requirements at all. In local telecommunication cases, conducted EMI from ESLs made it unable to use domestic electricity wiring as media for signal transmission. Also, other fluorescent lamps have caused both kinds of disturbance.

Finnish market surveillance test results with regard to ESLs have been a little better than those from Germany. According to Finnish tests, 43% of ESLs do not fulfil the standard. In Germany, 48% has failed. In ten cases, emissions from ESLs were so high that TUKES was obliged to restrict the distribution of the lamps (sales bans). Surprisingly, defects were found to be equally distributed between inexpensive and expensive ELS models.

Also in the USA, surprisingly high conducted emissions from some ESLs have been measured in the band 450kHz to 2MHz. The need for measuring was prompted by problems with AM radio reception while ESLs were in operation, and levels approaching 100dBµV occurred at the low end of the MF band. At 1.7MHz, the levels were more reasonable, but were still in the region of 70dBµV. The majority were reported as very high-order harmonics of the supply frequency, which suggest that the rectifier should have had shunt capacitors and/or soft recovery diodes. If these emission levels are common, where does that leave the troublesome subject of power line communication? It seems to both provide a case for relaxed limits and an indication that communication may be compromised by the very emissions that support that case! [6]

As serious problem seems to be that the ESLS originating from the Far East do not have uniform quality and quality can vary a lot between production runs. The high number of lamp and luminaire manufacturers in the Far East leads to competition between factories. There is a ready buyers market and factories are prepared to do nearly anything in order to keep their clients satisfied. It became apparent from project interviews that the importer himself could mar the quality of products e.g. through over negotiating the price down too much.

An open European market makes the importation business easy. It also tempts unskilled businessmen with dreams of big profits, and they usually make so-called ‘one-off’ business deals. They import a few containers of products from the Far East, distribute them quickly on the market, and then disappear. Such kinds of business change the price structure of the market, which impedes the operations of those importers who take care of their reputations by being responsible businesspersons.

The most troublesome interference case in Finland concerning metal halide lamps (MHLs), occurred in relation to a public swimming pool. The rated life time of the type of MHLs used was 10,000 hours usage, but after 2,000 hours, the sparking interferences of the lamp’s electrodes during normal operation caused serious interference to TV receivers in a neighboring house. When the lamps were exchanged for new ones, the event repeated itself after about 2,000 hours. One regrettable detail was that the pool had to be once again emptied before it was possible to change the lamps.

In Finland, there has been one very serious interference case caused by a single rechargeable torch model. After about half a year’s use the regulatory circuit together with the battery began to oscillate causing serious interference to one TV channel. Before identification of this problem source, many interference cases were noted all around Finland. In fact, this could be considered to be more of a battery-charger problem than a lighting interference one.

The four halogen sets we tested in 2002, fulfilled all the other testing, but they had enormous difficulties with mains harmonic currents. According to measurements made by the Swedish Authority, halogen lighting sets powered by an 'electronic transformer' might cause radiated interferences. Also, [2] supports Swedish views. It seems that almost all plasma lights do not fulfil the requirements for conducted emissions. However, they have not yet caused serious EMC problems in Finland.

*(Extracts from "*Lighting Interferences – An Ever Increasing Threat!*", by Jyri Rjamäki, IEEE 2005 International EMC Symposium, Chicago, Aug 8-12, ISBN: 0-78-03-9380-5, pp 7-12. For more instances of interference from lamps and luminaires, see Banana Skins 19, 40, 58, 102, 158, 159, 171, 198, 218, 271 and 322.)*

346) Rice cooker interferes with pacemaker, plus other examples of interference

This is an excerpt from a monthly newsletter that sends out interesting news items. I don't believe this is an April Fools' item, but then who knows? A Japanese woman's automatic rice cooker changed the settings on her pacemaker. Doctors doing a routine check up were baffled to find that the hi-tech pumping device they had implanted in the woman, 60, had been remotely adjusted. They contacted the manufacturer, who visited her home and found that a rogue rice cooker had somehow beamed signals to the device. [Source: A&A Economic Digest - April 2003 Edition, http://www.aacb.com/edigest/, 1 April 2003] [Quite plausible, in light of previous reported cases of electromagnetic interference on pacemakers]

--- From ACM Software Engineering Notes back issues:

* Arthritis-therapy microwaves set pacemaker to 214, killed patient (S 5 1)

* Retail-store anti-theft device reset pacemaker, man died (S 10 2, 11 1)

* Pacemaker locked up when being adjusted by doctor (S 11 1)

* Electrocauterizer disrupts pacemaker (S 20 1:20)

--- And from RISKS:

* Stores' shoplifting gates can set off pacemakers, defibrillator (RISKS-20.05)

* Heart pacemaker and implantable cardioverter defibrillator recalls and alerts involve 520,000 devices (S 26 6:8, RISKS-21.60)

(Sent in by Simon Brown, who saw it on the RISKS-LIST: Risks-Forum Digest Friday 4 April 2003 Volume 22 : Issue 67, FORUM ON RISKS TO THE PUBLIC IN COMPUTERS AND RELATED SYSTEMS (comp.risks), ACM Committee on Computers and Public Policy, Peter G. Neumann, moderator. Archived at http://catless.ncl.ac.uk/Risks/22.67.html and by anonymous ftp at ftp.sri.com, cd risks.)

347) Lightning strikes are a major cause of insurance claims in the U.K.

It is true that you are unlikely to be struck by lightning in the UK. But it may come as a surprise to know that around one-third of all insurance payments made by UK household insurers are compensation for damage caused by lightning strikes. Most of the damage is not caused by the direct strikes, but by the effects of more distant strikes. These produce voltage surges, most often on the mains electricity supplies, but also sometimes in telephone lines and other long cables.

*(Taken from "*When lightning strikes*" by Jim O'Connor in Electrical Engineering magazine September 2005, page 27, http://www.connectingindustry.com.)*

348) Cellular telephones can interfere with medical equipment – Mayo Clinic concludes

OBJECTIVE: To assess the potential electromagnetic interference (EMI) effects that new or current-generation cellular telephones have on medical devices.

MATERIAL AND METHODS: For this study, performed at the Mayo Clinic in Rochester, Minn, between March 9, 2004, and April 24, 2004, we tested 16 different medical devices with 6 cellular telephones to assess the potential for EMI. Two of the medical devices were tested with both new and old interface modules. The 6 cellular telephones chosen represent the different cellular technology protocols in use: Code Division Multiple Access (2 models), Global System for Mobile communications, Integrated Digital Enhanced Network, Time Division Multiple Access, and analog. The cellular telephones were tested when operating at or near their maximum power output. The medical devices, connected to clinical simulators during testing, were monitored by observing the device displays and alarms.

RESULTS: Of 510 tests performed, the incidence of clinically important interference was 1.2%; EMI was Induced in 108 tests (21.2%). Interference occurred in 7 (44%) of the 16 devices tested.

CONCLUSIONS: Cellular telephones can interfere with medical equipment. Technology changes in both cellular telephones and medical equipment may continue to mitigate or may worsen clinically relevant interference. Compared with cellular telephones tested in previous studies, those currently in use must be closer to medical devices before any interference is noticed. However, periodic testing of cellular telephones to determine their effects on medical equipment will be required.

*(Taken from: "*Cellular telephone interference with medical equipment*" by Tri JL, Severson RP, Firl AR, Hayes DL, Abenstein JP. Division of Foundation Telecommunications and Network Services, Mayo Clinic College of Medicine, Rochester, MN 55905, USA. 29 Oct 05, Mayo Clin Proc. 2005 Oct;80(10):1286-90, received via: Interference Technology eNews Oct 27 2005, http://www.interferencetechnology.com.)*

349) Five interference anecdotes from Tim Haynes

Radar-controlled gun on board a refitted warship. VHF transmissions would make the gun guidance go wild, pointing it into the superstructure etc. Lucky it wasn't loaded.

My own experience. Radio ham, transmitting on a UHF channel 433.325MHz hears own voice on a VHF transceiver, which was not normal. Received voice comes and goes with the movement of traffic. By watching the cars around, determines that it only occurs when a particular car is nearby - a Fiat Coupé. I ran this on EMC-PSTC when it happened and got Ferrari and Fiat writing to me wanting to know if it was their vehicle causing the problem. This was probably RF and switching causing the problem in the ECU of the Fiat.

Dual technology (IR and microwave) movement detectors used to control the lights in (a house / an office) would also detect radio transmission from passing cars using VHF radio. Soon the lights were going on and off like Xmas tree lights as all taxi, fire, police, ambulance drivers "blipped" their transmitters on passing.

Radio ham sitting in Tesco's car park waiting for wife to arrive with shopping. Talking on local UHF ham repeater. Man comes to his BMW7 series and with a flourish "blips" the remote unlock. Nothing happens. Another flourish. Still nothing. Walks around the car - checks number plate - yes it is his. Another flourish – nothing. Radio ham stops transmitting and leans out of the car window say "it will work now". Aggravated flourish! car unlocks and owner starts to load shopping.

Ham goes back to transmitting. Owner shoves shopping trolley into empty parking bay and gets into car. After two to three minutes, owner gets out of car and checks all doors are shut and gets back in. Gets out again and looks pitiful. Radio ham stops transmitting, leans out of window and say " it will start now!". Owner looks puzzled, gets into car and starts it first time, drives off at speed. Radio ham gets out of his old, non-electronic, car and paints another circle with black and blue quadrants in it on the front wing. Pulls flaps down on flying helmet and returns to reminiscing about days as fighter pilot. (This one is part true and part poetic license - you can decide which parts are which!)

(A collection of anecdotes sent in on 10th November 2005 by Tim Haynes.)

350) New Pentagon system suspected of interfering with garage door openers

A widespread problem with a mysterious radio signal that caused some garage doors in the Ottawa region to stop working has vanished. The powerful radio signal causing the problem stopped transmitting on Thursday afternoon, around the time CBC News contacted the U.S. Embassy to ask if it knew anything about it. The embassy denies that it had anything to do with it.

The signal was being transmitted at 390 megahertz, a frequency used by the Pentagon's new Land Mobile Radio System. The same frequency is used by garage doors openers, which started to malfunction around the city about two weeks ago. A similar problem has popped up around military bases in the States.

The world's biggest garage door manufacturer, the Chamberlain group, took the problem seriously enough to fly design engineer Rob Keller to Ottawa from its Chicago headquarters, with machinery to try to track the signal. But by the time he got there, the signal was gone.

*(Sent in by Doug Milligan, Senior Control Engineer, JNUP, who found it on CBC News "*Garage doors work after mysterious radio signal disappears*" Mon, 07 Nov 2005 13:01:24 EST, http://www.cbc.ca/story/canada/national/2005/11/07/garage-signal051107.html)*

351) Mobile phone ban continues on flights

The ban on the use of mobile phones by passengers on planes is set to continue. New tests by the Civil Aviation Authority confirmed that phones are still a threat to aircraft. The latest study found that the use of mobile telephones can adversely affect navigation and communication functions, producing significant errors on instrument displays and background noise on audio outputs. The CAA study recommended that as well as the usual on-board warnings about the use of mobiles, there should also be reminder notices in airport departure lounges and warnings by check-in staff.

The research backs up reports from pilots, who have stated that interference from mobiles has caused: false notification of unsafe conditions - for example, incorrect baggage compartment smoke alarm warnings; malfunction of aircraft systems; interrupted communications due to noise in the flight crew headphones; distraction of crews from their normal duties due to increased work levels and the possibility of having to invoke emergency drills.

Dan Hawkes, an avionics specialist at the CAA who supervised the research, said: "The tests demonstrate that mobile telephone use near an aircraft's flight deck or avionics equipment bay can adversely affect systems that are essential for safe flight. "For safety reasons the current policy of prohibiting the use of mobile telephones by passengers while the aircraft's doors are closed for flight must continue."

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352) TETRA radio system interferes with amateur radio

The roll-out of Tetra (Airwave) in Manchester is making itself known. I travel down the M60 between the A627M to the west of Bury, 2 or 3 times a week. I travel back and forth to work 5 days a week using the same route. I've used the same Amateur Radio transceiver (Kenwood) in my car for the last 5 years. What has changed? At various locations on the M60 and in Oldham, Ashton and Stalybridge, the 430MHz band is unusable for a number of miles on certain roads. The only way to get rid of the damn digital out of band carrier noise, is to switch on the ctcss (continuous tone coded squelch system), probably the equivalent on switching the fog lamps on! We are finding that increasingly it is necessary to take this course of action, or listen to the noise for the next few miles.

(Sent in by Graham Eckersall of Barcrest, on 10th Feberuary 2003. Sorry it took so long, Graham!)

353) Enhanced immunity testing required to overcome telecom failures

The International Telecommunications Union publishes the ITU-T Recommendations, which include the "K Series" of recommendations on the resistability (EMC immunity) of telephone-related equipment. Recently (Nov 2004) an amendment was published to its Recommendation K.20, which covers equipment installed in telecommunications centres. It seems that despite passing the very thorough and quite tough immunity tests in K.20, including the 'enhanced levels', a new design of line card installed in 1999-2000 suffered a large number of IC failures by 2002. Three years of intensive study resulted in a new test that reproduced the type of damage seen, and cards that have been modified to pass this new test seems to be much more reliable as a result.

The new test involves applying a voltage at the AC power frequency *between* two external ports (connectors for external telecommunication cables). The generator is 'floating' – not connected to the earth of the equipment under test as in the usual K.20 tests. Coupling resistors of between 100 and 200 ohms are used, and the voltage applied for periods of around one-third of a second. The voltage is increased gradually from low levels, until it exceeds the voltage at which the secondary protection devices in the equipment operate. In the case of the failing line cards above, the damage was replicated with coupling resistors of 140 ohms and a voltage of 145V rms.

*(Taken from: ITU-T Recommendation K.20, "*Resistibility of telecommunication equipment installed in a telecommunications centre to overvoltages and overcurrents*" Amendment 1, November 2004, "*Floating transverse power induction and earth potential rise test for ports connected to external symmetric pair cables*". ITU-T K-series Recommendations can be downloaded for a small fee by visiting http://www.itu.int/ITU-T/publications/recs.html, clicking on "K Protection against Interference" then scrolling down and clicking on the documents required. For manufacturers of equipment that could be connected to long signal, data or control cables, especially if those cables exit a building,*

applying the relevant K series immunity tests should help improve reliability. Some of them are similar to IEC 61000-4 series tests, but some are very different and/or much tougher.)

354) Digital box interference triggers 'SOS' alert and helicopter search

A faulty TV digital box sparked a rescue mission from RAF Kinloss by sending out a signal identical to those transmitted by vessels in distress. The Kinloss site in Moray, which co-ordinates rescue operations across the UK, detected an "SOS" call from the Portsmouth area on 5 January.

A coastguard helicopter spent two hours searching the harbour area before the signal was traced to dry land. An RAF spokesman said the signal had been a "complete freak". Telecoms regulator Ofcom was asked to look into the signal and confirmed the source.

RAF spokesman Michael Mulford said the Aeronautical Rescue Co-ordination Centre at the airbase had picked up the beacon from one of five orbiting satellites. He said it was transmitting on the major emergency frequency. "We traced it to Portsmouth Harbour, checked and found out there were no vessels in the area or missing planes." The rescue centre then contacted Ofcom, which was able to establish it was coming from a household.

"Digital boxes shouldn't be sending out signals, let alone maydays" Ofcom spokesman Mr Mulford added: "This is very very unusual, it's a complete freak and the odds of a digibox sending out such a signal must be astronomical. "The guy who owns it really should do the lottery because the chances of sending out a signal from a digibox and sending out precisely and exactly on a major emergency channel are far more than 14 million to one."

Ofcom has since removed the £50 Freeview box for tests. An Ofcom spokesman said: "This is a real one-off as digital boxes only receive signals. "They shouldn't be sending out signals, let alone maydays. The householder was happy to hand it over to our engineers who are trying to get to the bottom of the defect."

(Taken from BBC News / Scotland, Sunday, 15 January 2006, 13:03 GMT. This was sent in by both Graham Eckersall of Barcrest and by Alex McKay of Technology International (Europe) Limited, who got it from Claire Ashman of RFI.)

355) Marine mains supply harmonic distortion problems solved

The Ocean Challenger is a very high bollard pull cableship of UT746C dual role design, equipped with a Rockplough that allows for simultaneous cable lay and burial to 1.0m depth in fractured rock, 2.2m in sand/clays and 3.0m in soft soils. The Ocean Challenger's trenching operation is performed by a 2MW Remotely Operated Pipe-line Trenching Vehicle, referred to as the ROV PT1, which is capable of operating in depths of up to 2000m. The PT1 is fitted with ten 30kW electric thrusters for manoeuvring and four 300kW Jet Sword high volume flow rate electric pumps.

The electric thrusters and pumps are independently speed controlled via AC PWM VFD's (Variable Speed Drives) mounted in the surface module. These 400V AC drives are equipped with sinus output filters and 400V to 3300V step-up transformers. From the surface module the 3300V is fed down an umbilical cable to the 3300V thrusters and pump motors. The step up in voltage is required due to the voltage drops associated with very long cable runs extending as much as 2000m.

All individual PT1 drives on the ship were fitted with 3% AC line reactors to partially attenuate the harmonic currents they generate. When connected to the ship's normal power supply, the 1.5MW of AC drives produced too high a harmonic voltage distortion on the two 2800kVA shaft generators. This was partially due to the fact that generator power is more susceptible to voltage distortion than shore-based transformer power, because generators typically have much higher source impedance. With transformers, the impedance (Z) is usually in the order of 5% to 6% whereas for generators the subtransient reactance (Xd") is typically 12% to 20%. The higher the percentage source impedance, the higher the voltage distortion (and the worse its effects) for a given harmonic load.

Historically, to operate the ROV PT1 and its 1.5MW of drives, two deck mounted external generators have had to be rented in order not to breach the Det Norske Veritas (DnV) harmonic voltage maximum limitation of 5% and to prevent possible damage to the generators. This was an expensive proposition in respect to both financial outlay and required deck space.

CTC Marine Projects asked cable handling specialists, Parkburn Precision Handling, to provide a tailored solution, and Parkburn proposed the use of Lineator™ wide spectrum filters. These high performance harmonic filters are manufactured by Canadian company Mirus International Inc. who are represented in Europe by Harmonic Solutions Co. in the UK. The Lineator™ is a patented, multi-limbed reactor with a relatively small capacitor bank whose output, when connected to AC or DC drives, produces a trapezoidal voltage which forces the input rectifier devices to conduct for a longer time period and with smaller peak currents. This has the effect of reducing the 'total harmonic current distortion' (Ithd) to near 5% regardless of whether the VFD is equipped with a reactor or not.

CTC Marine Projects installed 2 x 750kW Lineators™, one for each of two groups of 5 x 30kW thrusters and 2 x 300kW pump drives in a self contained deck module. During the following sea trials, ships staff monitored both the operation of the two shaft generators and the VTHD on the main switchboards. The ship's electrical engineer reported that the generators operated flawlessly and at no time did the VTHD ever rise above 1.4% and 1.6% on their respective switchboards. The installation of the two 750kW Lineators™ allowed the vessel to meet the 5% voltage distortion limit of the DnV without the need for the rented generators and the additional deck space they required.

(Extracted from "Homing in on Harmonics", an article in Offshore Engineer magazine, February 2006 Issue, pages 55-57, sent in by John Symonds of REO (UK) Ltd, on 27 Jan 06, http://www.offshore-engineer.com/the-magazine/issue-archives/february-2006/current-issue/?tx_ttnews%5Btt_news%5D=72663&cHash=d71b58786b.)

356) Piezo gas lighter controls tape player

In the kitchen we have a radio/tape/cd and recently the tapes have been playing with very poor sound quality. No amount of head cleaning has improved the sound. By chance we found that operating the piezo gun to light the gas hob fixes the problem. Must be switching some 'hiss' correction circuit for which there is no external control, button switch etc.

I think that the transient switches on something that the play button ought to switch on but doesn't. Or rather something it used to switch on but doesn't. However when you buy a radio/CD/tape including a remote all for £42 I guess you get what you pay for - it worked OK until the guarantee was over!

Sometimes when the play button is pressed the sound is OK, but frequently it isn't. When the sound is poor the piezo lighter always seems to fix it. If it is repeatable (and it seems to be so) then it is a good demonstration that external EM threats can change the performance of an electronic circuit - in this case it is beneficial, but it might have been the other way round.

(Sent in by Dave Imeson of Compliance Europe Ltd, on 31 Jan 06.)

357) Radar dome suspected of interfering with car immobilisers and lights

Reports that a radar dome in Norfolk is causing electrical problems with cars are being investigated by the Ministry of Defence (MoD). Motorists say their engines and lights have cut out, and their speedometer dials swing up to 150mph as they drive past the Trimingham radar unit.

Neil Crayford, who runs a garage near the dome, said in the past two months, 30 car owners had reported problems. On Monday, an MoD spokeswoman said the claims were being investigated. Mr Crayford said one night his own car's headlights and dashboard cut out for a few seconds as he drove past the dome in convoy with a colleague - who suffered the same fate.

The former RAF radar operator said: "Something must have changed - either the frequency or output - for this to happen. "I lodged an official complaint with the MoD two weeks ago, but incidents are still happening. We get about five a week, and had three more on Friday."

An MoD spokeswoman said: "We are aware of claims that the remote radar head may be interfering with car immobilisers and we are investigating. "There are other users outside the military that operate on the same frequency as the radar, but there is a possibility we could be causing some problems with cars."

(BBC News / England / Norfolk / "Fears radar dome affecting cars", http://news.bbc.co.uk/1/hi/england/norfolk/4732096.stm. Posted to the IEEE's emc-pstc newsgroup on 24 February 2006, by Iain Summers.)

358) Cellphones can interfere more strongly with aircraft navigation than previously believed

A study by Carnegie Mellon University researchers in the Department of Engineering and Public Policy (EPP) has found that cell phones and other portable electronic devices, like laptops and game-playing devices, can pose dangers to the normal operation of critical electronics on airplanes. The study will be featured in an article appearing in the March issue of IEEE Spectrum.

"We found that the risk posed by these portable devices is higher than previously believed," said Bill Strauss, who recently completed his Ph.D. in EPP at Carnegie Mellon. "These devices can disrupt normal operation of key cockpit instruments, especially Global Positioning System (GPS) receivers, which are increasingly vital for safe landings." Strauss is an expert in aircraft electromagnetic compatibility at the Naval Air Warfare Center in Patuxent River, Md.

With support from the Federal Aviation Administration, three major airlines and the Transportation Security Agency, EPP researchers crisscrossed the northeast United States on commercial flights, monitoring radio emissions from passenger use of cell phones and other electronic devices. They tracked these radio emissions via a broadband antenna attached to a compact portable spectrum analyzer that fit into an innocuous carry-on bag.

"A laptop computer controlled the system and logged the data," said Granger Morgan, head of the EPP Department. "While we looked primarily at wireless phones, we also discovered that emissions from other portable electronic devices were problematic."

The researchers found that on average one to four cell phone calls are typically made from every commercial flight in the northeast United States. Some of these calls are made during critical flight stages such as climb-out, or on final approach. This could cause accidents, the investigators report.

Both Strauss and Morgan, along with Carnegie Mellon researchers Jay Apt and Dan Stancil, recommend that the Federal Communications Commission (FCC) and the FAA begin to coordinate electronic emission standards. At the moment, there is no formal coordination between the two federal agencies. The researchers also recommend routine monitoring of on-board radio emissions by flight data recorders and deploying specially designed tools for flight crews to monitor passenger use of electronic devices during final approach.

While the FCC recently suggested that it might be appropriate to allow passengers to use cell phones and other electronic devices on airplanes, Morgan disagrees.

"We feel that passenger use of portable electronic devices on aircraft should continue to be limited for the safety of all concerned," Morgan said.

(Carnegie Mellon University Press Release, Feb 28, 2006, www.cmu.edu/PR/releases06/060228_cellphone.html, Contact: Chris Swaney, +1 412-268-5776. Also featured in ITEM's Interference Technology E-News, www.interferencetechnology.com, March 4, 2006.)

359) Interference increasing in the aircraft bands

Very little has happened to Section 21 recently other than a reduction of the limits in the receiver band for certain test categories and the banning of circularly polarised antennas, with both horizontal and vertical testing being required above 25MHz. However, more significant changes are proposed for the "F" revision.

The reduction of limits was required because of the increasing interference occurring, in aircraft operation, in the aircraft receiver bands. One theory proposed by the author is that this problem has been caused by the increasing use of absorber lined chambers without an accompanying reduction in the test limits. Because the RF absorber damps out the resonances of the chamber the radiated emissions can appear lower at some frequencies. In an experiment, emissions from a simulated EUT were measured in an unlined chamber as previously allowed by early versions of DO160, and the same chamber partially lined with RF absorber. A reduction in peak emissions of up to 26dB was observed in the semi-anechoic chamber.

*(Extracted from: "*To DO160E and Beyond*", by Dr Nigel Carter of Qinetiq, EMC-UK Conference, Newbury, October 11-12 2005, pp 127-130.)*

360) EMI suspected of causing electrical meltdown

Question: I have a Rover 827 Si, bought new in Spain in 186. When I travelled to the UK recently, it suffered a major electrical meltdown and was rendered immobile. It has done little more than 40,000 miles and is otherwise in first-class condition. Is there are alternative to scrapping it?

Reply: Don't despair yet. It's possible that, while parked, the car encountered electronic interference, possibly from an illegal short-wave radio, or from police or ambulance transmitters, to which its immobiliser system was vulnerable. Try www.remotekey.co.uk or www.alarmremotes.co.uk.

*("*Start Wreck*", in 'Honest John's' motoring questions column, The Daily Telegraph Motoring Section, 18 Feb 2006, page 10, www.telegraph.co.uk.)*

361) Document shredder interferes with set-top box

Operating my personal document shredder crashes my digital TV set-top box, although it is 5 metres away. Toggling the on/off button on the set-top box restores normal operation.

(Sent in by Peter Cryer, 2nd February 2006.)

362) Lack of good PCB EMC design delays product launch

The day after attending your course on Advanced PCB Design for EMC, during which you emphasised the exponential relationship between cost of modification and the date of market introduction, I went back to my OATS and tested some more customers' products. One of them emphasised the above point – EMC testing was the last thing this manufacturer thought of, and a 16dB over Class B 'surprise' was the result.

Adding ferrites to the cables made no difference as most of the noise was radiating directly off the PCB. The company has had to engage an EMC consultant to try to fix their 8 layer board, and the product shipping has been postponed.

(Sent in by Bruce Holdsworth, Sydney, Australia.)

363) When is a dozen ferrites too many?

This job started out just the same as any. With the client present I set up the EUT on the test table, warmed up the analyser and began the test. Almost immediately I could tell the emissions from the EUT were going to exceed the 40dBuV Class A 10 metre limits. A quick look at the other frequency ranges up to 1GHz confirmed this. The emissions were over the limit everywhere. Ok I said to the client, lets take a look inside and see if we can come up with a solution. Upon opening the fairly large cabinet I was astounded to see at least a dozen clip-on ferrites randomly attached to cables. I asked why so many? The reply was "We had them back at the workshop so I just put them in".

I suggested that we should remove the ferrites and take a baseline reading and start work from there. With both hands now full of ferrites, we headed back inside. Although the EUT was still failing Class A, a quick measurement showed the emission levels had not changed! I asked the client to take ONE ferrite with him and to go out to the EUT, open the cabinet, stand to the side and to carefully touch the cables inside with out disturbing their position. (Obviously this method is suitable for low voltage equipment only) while I watched the analyser. Sure enough, as soon as he placed his hand on the offending cable the analyser readings dropped. "That's it" I called to him to clip the ferrite on that cable and the rest is history. The offending cable was a noisy RS485 cable and ONE clip-on ferrite cured the entire problem.

(Another anecdote sent in by Bruce Holdsworth, Sydney, Australia.)

364) Can interference from passenger electronic devices make aircraft unsafe? – Part 1

More and more passengers are bringing cellphones, PDAs, laptops, DVD players, and game machines on board aircraft. All of these items emit radiation and have the potential to interfere with aircraft instrumentation. More and more passengers, however, do not believe that using portable electronic devices presents a risk to passenger safety. We, on the other hand, have had our doubts that such use was safe. Over the course of three months in late 2003, we investigated the possibility that portable electronic devices interfere with a plane's safety instruments by measuring the RF spectrum inside commercial aircraft cabins. What we found was disturbing. Passengers are using cellphones, on the average, at least once per flight, contrary to FCC and FAA regulations, and sometimes during the critical flight phases of takeoff and landing.

Regulations already permit a wide variety of other portable electronic devices (PEDs) – from game machines to laptops with Wi-Fi cards, to be used in the air today. Yet our research has found that these items can interrupt the normal operation of key cockpit instruments, especially Global Positioning System (GPS) receivers, which are increasingly vital to safe landings. Two different studies by NASA further support the idea that passenger's electronic devices dangerously produce interference in a way that reduces the safety margins for critical avionics systems.

There is no smoking gun to this story: there is no definitive instance of an air accident known to have been caused by a passenger's use of an electronic device. The data support a conclusion that continued use of portable RF-emitting devices such as cellphones will, in all likelihood, someday cause an accident by interfering with critical cockpit instruments such as GPS receivers.

The study found that intermodulation between some cellular phones caused emissions in the frequency bands used by an aircraft's GPS and distance-measuring equipment. The report identified other combinations of common passenger transmitters that could potentially produce intermodulation effects in aircraft communication and navigation RF bands.

GPS-certified landing approaches are now widely used in general aviation. Though most airliners presently use instrument landing systems, use of GPS technology will increase significantly over the next few years. There are three times as many GPS-certified approaches as instrument landing system approaches in the United States.

In March 2003, acting on a number of reports from general aviation pilots that Samsung SPH-N300 cellphones had caused their GPS receivers to lose satellite lock, NASA issued a technical memorandum that described emissions from this popular phone. It reported that there were emissions in the GPS band capable of causing interference. Disturbingly, though, they were low enough to comply with FCC emissions standards.

In one telling incident, a flight crew stated that a 30-degree navigation error was immediately corrected after a passenger turned off a DVD player and that the error reoccurred when the curious crew asked the passenger to switch on the player again. Game electronics and laptops were the culprits in other reports in which the crew verified in the same way that a particular PED caused erratic navigation indications.

*(The above are some paragraphs selected from: "*Unsafe at any airspeed? Cellphones and other electronics are more of a risk than you think*", Bill Strauss, M Granger Morgan, Jay Apt and Daniel D Stancil, IEEE Spectrum, March 2006, pp 38-43. The IEEE paper includes many references for further information.) (Editor – the USA's 2001 DOT/Volpe report – see Banana Skins 223, 227 and 230 – said that interference, either intentional or unintentional, could deny GPS access, so I am totally amazed that GPS is permitted to be relied upon for aircraft landings! Any comments from the CAA?.)*

365) Can interference from passenger electronic devices make aircraft unsafe? – Part 2

While flying home from a house-hunting trip in 1981 in a turboprop Short Bros. 360, I began feverishly working out possible mortgage payments on a cheap credit card calculator. Soon the stewardess was walking down the aisle asking if anyone had anything "electrical" they were using. I replied that I had a calculator, that was electronic but not electrical – that is, it had no motors or anything. She borrowed my calculator and took it to the cockpit.

She returned in a few minutes and admonished me with words like, "Please don't use that anymore, because when you press the keys it makes the needles in the cockpit swing around." Needless to say, I complied. As pointed out in “Plane Talk about Cellphones” [Spectral Lines, March], much of the data on signals interference in aircraft is informal and hearsay – but this is my anecdote; I witnessed it myself. I vote for keeping the ban on cellphones.

(Letter from Chris Jones responding to an editorial about the article mentioned in Banana Skin No. 363 above, in “Forum” in the IEEE Spectrum, May 2006, page 4, www.spectrum.ieee.org.)

366) Can interference from passenger electronic devices make aircraft unsafe? – Part 3

Is it safe to use cellphones on airplanes? The real question should be: “Is it safe for passengers to use any electronic equipment on airplanes?” My older notebook computer interferes with VHF Channel 11 on my TV. My newer notebook doesn’t, but my older one didn’t when it was new, either. And when I’m in my home office with the FM radio on, I always hear a buzz on the radio just before my cellphone rings. Granted, aircraft may not be using the VHF and FM bands, but if these devices cause interference on these bands, how can we be sure that they’re not causing interference on other bands?

(Letter from Michael L Nelson responding to the article mentioned in Banana Skin No. 363 above, in “Forum” in the IEEE Spectrum, May 2006, page 4, www.spectrum.ieee.org.)

367) Airbags triggered by ESD

Holden Commodore, Statesman, Monaro and Crewman models fitted with side airbags are being recalled after some cars were found to have earthing problems which may inadvertently deploy a side airbag. Holden says the deployment can occur when the car is stationary and is caused by a static discharge as an occupant exits the car. Owners can call their Holden dealer for a simple fix, which involves fitting two small earthing springs and takes just a few minutes.

*(From the “*Drive*” section of ‘The Press’, Christchurch, New Zealand, Wednesday March 15 2006, page E8.)*

368) Co-location of wireless services causes interference

This veritable cocktail of spectrum and services is leading to a more challenging interference scenario – and not just in the US. As services operating in neighboring frequency bands are co-located, significant – and initially unforeseen – interference issues can arise.

This has already been observed extensively in China and Brazil, where a “cross-pollination” of 900-MHz Global System for Mobile communications (GSM) and 800-MHz code-division-multiple-access (CDMA) services exists. In such cases, GSM services have suffered significant interference – and hence quality problems – as the direct result of co-location with CDMA.

Similar issues are also being experienced by US carriers with other combinations of services – and such problems will only increase with increasing demands for wireless bandwidth and services.

*(Taken from: “*Filtering Compromises from Co-Located Systems*”, Ganesh Krishnan and Andre Doll, Microwaves & RF, March 2006, pp 57-64)*

369) Optical microphone has no emissions and is unaffected by interference

The Security Optical Microphone (SOM) from Winkelmann UK Kingfisher is used by many law enforcement agencies. Unlike traditional microphones, which can be detected using a conventional detector during a counter surveillance sweep, the SOM uses fibre optic technology and an extremely small 6mm diameter head which, when installed, is invisible to all but the most rigorous searches, and it is unaffected by interference (a major source of induced noise in conventional equipment).

*(Taken from: “*Breakthroughs in Defence*”, Nick Morris, Electro-Optics, April/May 2006, pp 17-18).*

370) Anti-jamming system for satellite operator

UK Defence specialist QinetiQ is to supply Space Communications Corporation of Japan with a geolocation system that will allow the Tokyo-based company to identify and accurately locate the source of any interference to its satellites. The US Department of Defense bought three such systems last year. Nigel Smith, QinetiQ’s satID commercial director in the USA, commented: “Satellite interference is a growing problem for both military and commercial operators and satID provides a rapid and effective solution to that problem.”

*(From “*Japanese Satellite operator turns to UK for anti-jamming system*”, IET Communications Engineer, April/May 2006, page 4.)*

371) AC motor and contactor interferes with satellite receiver around 4GHz

I have a 3 phase 480V 50A contactor and motor causing interference to a C-band satellite receiver in the 3700-4200MHz range, what are some options to prevent this?

(Question posted by JD Moats on Conformity magazine's "Ask the Experts" Noticeboard, 21 March 06, www.conformity.com)

372) FCC fines manufacturer US$75,000 for using emergency radio bands

The Federal Communications Commission (FCC) levied a proposed forfeiture of US$75,000 against San Jose Navigation, Inc. for marketing four models of the company's GPS signal re-radiator kits that operated on restricted frequency bands allocated for safety-of-life operations.

In this instance, the Commission acted on complaints from the National Telecommunications & Information Administration, the Department of Transportation and other federal agencies which had expressed concern that the GPS re-radiator equipment could potentially interfere with government GPS operations.

*(From: "*FCC Continues to Crack Down on Marketing of Unauthorized Equipment*", in the News Breaks section of Conformity magazine, June 2006, page 10, www.conformity.com.)*

373) FCC levies US$1 million fine on audio equipment manufacturer for non-compliance

As we've previously reported (see Conformity May 2006, page 8) the Federal Communications Commission (FCC) recently proposed a US$1 million forfeiture against Behringer USA, Inc. for illegally marketing over a five year period as many as 66 different models of mixers, amplifiers and digital effects processors, none of which had been verified for compliance with FCC requirements.

*(From: "*FCC Continues to Crack Down on Marketing of Unauthorized Equipment*", in the News Breaks section of Conformity magazine, June 2006, page 10, www.conformity.com. Another news item on this can be found at: http://www.rwonline.com/dailynews/one.php?id=8552. The complete text of the FCC's Notice of Apparent Liability against Behringer can be found at http://www.fcc.gov/eb/Orders/2006/FCC-06-13A1.html, also available in Word and PDF versions.)*

374) Vehicle engine management systems suffer interference

Q: My 45,000 mile four-year-old Hyundai Accent 1.3i sometimes cuts out, although it restarts almost immediately. I took the car to my local mechanic, but after three hours (and £140) he was unable to isolate the problem. He thinks the ECU might have failed.

A: This is happening to quite a lot of cars at present. It seems that powerful electric fields emitted by power lines and government establishments upset vehicle electronics – it's a particular problem when cars have CAN-bus multiplex wiring systems.

(From the "Honest John" column in the Daily Telegraph's Motoring section, Saturday May 27 2006, page 9, www.telegraph.co.uk/motoring.)

375) Light fittings can interfere with fire detectors

Fire detectors close to a light fitting may pick up electrical interference, resulting in false alarms or, even worse, the masking of a real alarm. Detectors affected must be moved.

*(From "*Top 10 fiery errors*", Electrical Products and Applications magazine, May 2006, page 17.)*

376) Major railway operators ban use of handheld radio transmitters in sensitive areas

The railway industry is very conscious of the public's perception of railway safety and for this reason there is little published information relating to interference with railway systems from hand-portable radios. Where such information is in the public domain, then the information is couched in general terms and does not make specific reference to individual incidents.

It should be noted that where the railway authorities have concerns (possibly based on experience) that interference from hand portable radio constitutes a hazard then mobile radios are excluded from areas where susceptible equipment is located.

The results of interference from hand portable radio can be broadly broken down into two areas:

1) Nuisance: – Interference with individual non-safety-critical systems.
   a) Low level interference on audio systems
   b) Interference with position detectors, e.g. internal coach door activation, automatic taps in toilets, etc.
   c) Interference on computer systems being used on railway control and service operations.

This type of interference is not covered by this paper other than instances where the susceptible equipment is part of a larger system.

2) System Interference: – Interference with equipment and/or systems that are essential to the operation of the railway and which may be safety critical.

System Interference: The distributed nature of railway systems together with their built-in safety features makes it difficult to isolate particular interference incidents. For this reason much of the information in the public domain is not specific. It should also be noted that the safety regimes presently in place in the railway industry would implement changes to equipment and/or operational procedures in order to reduce any safety issues to acceptable levels.

Examples of interference to railway systems that are in the public domain are:

a) Interference with train or signalling systems. Ref [1] makes the following statement "It is not expected that mobile communications will pose a threat to these systems although it has been noted that problems have occurred with stopped trains and technicians have been advised not to use BAND III radio in these areas."

b) Interference with trains. Ref [4] indicates that some older electronic equipment has been found to be unexpectedly sensitive to emissions. Examples of this are the brake units fitted to HST power cars which were found to be affected by mobile telephones and NRN radio.

c) Interference with signalling systems. Ref [9] states: "In South Jutland, the Danish state railways, DSB, have forbidden mobile phones on all marshalling yards in the district. The reason is that GSM telephones have caused the signal system to switch from green to red, and have also caused interference in the ticketing system used."

Supporting these incidents in the public domain there are the well known restrictions within the majority of European railways against using hand-portable radios in locations which contain safety critical equipment, e.g. Signalling Equipment Rooms. Railways that are known to implement such restrictions are Network Rail, London Underground and CTRL.

While the number of reported incidents in the public domain is small, the fact that major railway operators have excluded hand portable radios from sensitive areas leads to the conclusion that there is a perceived problem with interference from hand portable radios within railway systems.

In the preamble to the EN 50121 standards (the EMC standards used by the Railway Industry to achieve conformity with the EMC Directive – Editor) the following statements are made:

Safety considerations are not covered by this standard. In special situations, where the level of disturbances may exceed the levels considered in this standard, e.g. at a special location or where a hand-held transmitter is used in close proximity to an apparatus, then special mitigation measures may have to be employed.

[1] LINK Personal Communications Programme, Collaborative Research, Electromagnetic Compatibility Aspects of Radio-based Mobile Telecommunications Systems, Final Report, http://www.ofcom.org.uk/static/archive/ra/topics/research/topics/emc/linkpcp/index.htm

[4] Rail Safety & Standards Board, ERTMS Engineering Interfaces, Report 02/T087/ENGE/002/TRT, August 2003,
http://www.rssb.co.uk/pdf/reports/research/ERTMS%20train%20interface%20specifications%20-%20ERTMS%20engineering%20interfaces.pdf

[9] "Application Areas for MobilePhoneGuard™", www.mobilephoneguard.se/eng/appl_eng.htm

*(Extracted from: "*The Use of Hand-Portable Transmitters in the Railway Environment*" by John Whaley, presented at EMC-UK 05, Newbury, October 11-12 2005, pages 84-91 in the conference record, copies available from Nutwood UK: send email to Pam at pam@nutwood.eu.com.)*

377) Windshield washer interferes with ABS

In the development cycle of a certain automobile, it was found that the pump motor for the windshield washer was creating interference and causing an ABS warning light to activate. This vehicle's brake lines were coated with a new material which had a much higher conductivity than on older models.

It was later determined that the pump motor was generating a transient that was directly coupled to the ABS module by the new conductive coating on the brake lines. This transient was interfering with the ABS module and activating the ABS warning light.

A capacitor was placed inside the pump motor housing and the housing material was changed from plastic to aluminium to fix the problem.

*(From: "*The Back Page…Examples of EMC Related Problems*" in the EMC Society of Australia Newsletter, June 2006, Issue No. 33, www.emcsa.org.au.)*

378) Mobile phones can interfere with medical equipment

Patients are at risk if medical apparatus malfunctions due to EMC interference from mobile phones. There are several types of equipment which can be subject to interference. Infusion pumps can cause equipment malfunctions on dialysis wards, by racing or fluctuating in speed. This results in patients receiving the wrong dosage. The temperature level of incubators has been affected. Reports have been received that the temperature of incubators has been set at the maximum level. Ventilators have malfunctioned. On one occasion, an electrically-driven wheelchair was caused to move unintentionally by the communication radio in a taxi. The handicapped person involved asked the taxi driver to use his radio again to confirm that it was actually causing the wheelchair to move and it was.

*(Taken from "*Application Areas for MobilePhoneGuard™*", www.mobilephoneguard.se/eng/appl_eng.htm)*

379) Mobile phones can interfere with aircraft systems

Navigation and control instruments can be caused to malfunction. During the approach of an Alitalia aircraft at Turin airport on 31 December, 1995, one of the 160 passengers onboard switched on his mobile phone(picture), thus blocking the plane's autopilot system. There was also interference with the pilot's contact with the control tower.

The conditions were dense fog. The pilot realized what had happened and, displaying a cool nerve, was able to take manual control of the aircraft and land it without further incident. (Source: TT 960103).

*(Taken from "*Application Areas for MobilePhoneGuard™*", www.mobilephoneguard.se/eng/appl_eng.htm)*

380) TVs susceptible to the frequency and type of RF modulation

The annex to IEC 61000-4-3 explains that it was decided to use amplitude modulation (of the radiated RF test signal) and not pulse (digital) modulation as the differences were small. However, when testing televisions for immunity to GSM mobile services, the use of a 200Hz modulation was disastrous, and was only solved by using the correct 186Hz signal.

The problem arose because 200Hz was a harmonic of the television frame frequency *(which is 50Hz in the EU – Editor)*. This points to the criticality of such tests, which when viewed in the wider context highlights the impracticability of simulating all digital services during RF immunity testing. So should we be looking at a new approach for RF immunity testing?

*(Taken from: "*Standards – are we getting what we need*" by Peter Kerry, President of CISPR, EMC-UK 05, Newbury, 11-12 October 2005, pages 49-51 in the conference record, copies available from Nutwood UK: send email to pam@nutwood.eu.com.)*

381) Hunting Radio Howlers – Government Vans on the Track (historical)

The wireless oscillators do not have it all their own way. Re-radiated howls which spoil reception for other listeners are to be tracked down by Government experts employing the latest methods. By the end of this month, the first of the new direction-finding motor-vans will, it is expected, be delivered to the Post Office engineers who are specially concerned with stamping out oscillation. These vans will do their best to work in couples.

The general idea is to listen to any notable howls on frame aerials. A compass bearing is taken of the quarry and the aerial is swung round until the sound reaches a minimum. This gives a still closer reading. Next, the van moves on to another spot and the procedure is repeated. The bearing, naturally, is changed (just as a lamp-post changes it's apparent position as you walk past it).

Finding the 'Lair': When the bearings are plotted out on an ordnance map of the district, you will get two or more lines cutting each other and the spot where they intersect marks the 'lair' of the oscillator, or thereabouts, for an aerial is a length of wire which does not give a very exact 'fix' for this form of land navigation. Two vans, in wireless telephonic touch with each other on a wavelength that does not interfere with broadcasting, can conduct a hunt in quite a short time and the offending listener is eventually run to earth.

(Just to prove that EMI is nothing new, the above item is from the Daily Mail, 21 April 1926, reprinted in Automotive EMC Newsletter 4th June 2006, www.autoemc.net. The problem described was caused by

the local oscillators in early 'superhet' radio sets, which could be re-radiated from the antenna or mains wiring and cause interference.)

382) Airport transmissions interfere with some cars on nearby motorway (1)

While towing a caravan south between junctions 24 and 23 of the M1 recently, the turbo of my 29,000 mile Audi A4 TDI suddenly shut down. There were no warning lights or mechanical noises, simply a serious loss of power. I struggled off the motorway and a mobile technician from Audi Assist checked the car the following day. He ran a series of electronic checks but could find no fault other than a "possible" mechanical turbo failure. On the subsequent test run, the turbo was working again and In have completed a further 200 miles without incident. Could the problem have been due to the electronic interference that has previously been mentioned in your column? A.S., Doncaster.

'Honest John' replies: Another reader puts it down to the automatic aircraft landing system at East Midlands Airport. It transmits to planes coming in across the M1 and can apparently interfere with badly shielded car electronics.

*(From '*South Shields*' in the 'Expert Advice' section of the 'Motoring' section of the Daily Telegraph, Saturday August 19, 2006, page 9, www.telegraph.co.uk/motoring.)*

383) Airport transmissions interfere with some cars on nearby motorway (2)

For many years, automakers have performed electromagnetic compatibility testing of automobiles before their release to consumers. However, as the electronics content of vehicles becomes greater every year, it expands the potential for component or system failure caused by external sources of electromagnetic radiation.

One challenge has come from commercial and military airport radar systems that operate at frequencies from 1.2 to 1.4GHz and 2.7 to 3.1GHz. Cases have been reported in which vehicles near airports and military bases suffered degradation or even failure of critical vehicle systems including braking controls and airbag deployment. As a result, Ford Motor Company and General Motors Worldwide (GMW) have introduced sections in their immunity standards for component testing when exposed to radar pulses, such as those at the 600V/m level.

*(Taken from "*Required Amplifier Power in Automotive Radar Pulse Measurements*", by K. Gove, H-P. Bauer and V. Rodriguez-Pereyra, Evaluation Engineering, August 2006 Feature Article, http://evaluationengineering.com/archive/articles/0806/0806required_amplifier.asp.)*

383) Walkie-talkies interfere with electronic door locks on aircraft cockpits

Here's another good reason why the use of mobile phones on planes should remain banned: your call could lock the crew in the cockpit. The problem was first reported in December 2003, when a Northwest Airlines mechanic scrambled the electronic locks on the security doors of an Airbus A330 by using his walkie-talkie in the vicinity of the flight deck.

By June 2004, Boeing had discovered that similar problems affected 1,700 of its aircraft. The solution has been a two-year, top-secret repair schedule. Boeing reports that all its jets were fixed by the end of September, while Airbus says it still has doors to mend. The faulty system has now been augmented by a technical innovation described as "a manually operated sliding bolt".

(Taken from 'News' in the 'Travel' section of the Sunday Times, October 16 2005, page 19, www.sunday-times.co.uk.)

384) Interference and the European Rail Traffic Management System (ETRMS)

Emissions: Until relatively recently the only limits on emissions from electrical equipment on rail vehicles operating in the UK were those related to signalling interference. Problems of incompatibility between equipment within the train were dealt with on an ad-hoc basis. As a result most electronic equipment on older vehicles is relatively "hard" and does not suffer problems due to interference from adjacent electronic equipment.

However, some older electronic equipment has been found unexpectedly sensitive to emissions. Examples of this are the brake units fitted to HST power cars which were found to be affected by mobile telephones and NRN radios. One type of CSR radio unit which is often affected by conducted emissions from conventional control equipment has been found to be non-compliant with EN 50121 immunity requirements.

The conclusion from this is that compliance with the current standard set out in EN 50121-3-2, tables 4 to 6 will avoid introducing unreliability into existing train borne systems in the majority of cases. To cater for the small percentage of vehicles where problems will be encountered it is recommended that, when ERTMS systems are fitted to vehicles that have electronic systems without proven immunity, tests are carried out on such systems to ensure compatibility.

Immunity: For similar reasons to those stated above with regard to emissions, the situation with regard to immunity requirements for new electronic equipment is perhaps even less certain. There is a large amount of highly inductive electrical equipment on most rail vehicles and on older vehicles this has never been subject to any formal assessment of electromagnetic emissions.

The author is personally aware of electrical fields in the passenger saloon of a 25kV electric multiple unit that were so strong whenever the main vacuum circuit breaker was operated that a 12mm arc would be generated between two 1m long conductors held in free air. This phenomenon was accentuated by a faulty connection to the main transformer secondary output but similar effects were also observed on other units.

The arc would be alarming to passengers but apparently had no effect on the electronic traction control equipment. Historically the most troublesome sources of interference have been less spectacular and associated with control gear at battery voltage. The required immunity limits in this area are well documented in RIA 12, EN 50121 and EN 50155.

It has been suspected that older vehicles may generate interference levels outside these limits. In an attempt to provide some quantifiable measure of the typical conducted EMC environment, measurements were taken on a small sample of vehicles. These consisted of a diesel locomotive, an electric locomotive, a DMU and an EMU. The results of these tests are contained in report 02/T087/ENGE/014/TRT - ERTMS Engineering Interfaces – Supplies and EMI Tests.

The test results suggest that the conducted electromagnetic interference on older rail vehicles is broadly in line with the present test limits in EN 50155 and EN 50121-3-2. Some electrical disturbances outside the limits were measured as follows: -

- Repetitive high frequency waveforms were noted in several cases. The amplitude of these gave no cause for concern but the frequency was above the test limits in EN 50121 and RIA 12 and could corrupt data signals.
- Significant voltage differentials were found between negative and the vehicle frame in some cases. This may cause problems if care is not taken with equipotential bonding of ERTMS components.
- On some vehicles there was a high level of ac ripple superimposed on the dc supply. This need be nothing more than an irritation to the designers provided it is considered at an early stage in the design.

It is expected that more extreme electrical disturbances will be found in service due to random combinations of circumstances that occur from time to time. It is recommended that the ERTMS specification should call up full compliance with EN 50155 (*despite the evidence in this report that this will not be sufficient in some cases – Editor*).

Power supplies – Voltages: The tests carried out on Class 155 DMUs indicated that, even under ideal conditions, the voltage would dip below the lower limits for several seconds during engine starting. Anecdotal evidence indicates that a 110V dc diesel locomotive battery voltage can dip to below 15 V dc during cold weather starting. It is recommended that this be brought to the attention of prospective suppliers of equipment via a requirements specification. It is essential that during such dips, the equipment continues to function within specification or shuts down to a safe condition.

There may be significant ripple on supplies on certain vehicles under different charging conditions. The current requirement according to EN 50155 is for a maximum or 15% ripple on the nominal dc voltage. In previous years, the limit according to RIA 13 was 30%. Tests carried out on vehicles indicate that even this expanded limit is sometimes exceeded (*actually up to 50% - Editor*).

It will be noted that there is a significant difference between the measured ripple for Class 43 at 0.4% and the worst case on Class 508 at about 50%. It is assumed that the difference is due to the characteristics of the load because the basic dc supply system is the same in all cases, comprising an ac source and simple rectifier. The conclusion that must be drawn is that significant ripple can occur in many types of vehicle when certain conditions exist. It is recommended that this possibility be drawn to the attention of prospective suppliers so they can take appropriate precautions.

(Extracted from the Rail Safety & Standards Board Report 02/T087/ENGE/002/TRT, Issue 3 08/03, sections 11.1, 11.2 and 11.3 on pages 16, 17 and 18. The report is available from www.rssb.co.uk, but easier to find with a Google search for 02/T087/ENGE/002/TRT.)

385) Search and rescue transmitter interferes with car alarms, central locking and garage door openers in Las Vegas

At first the motorists of Las Vegas and neighbouring Henderson suspected that machines had taken over the world: thousands of car alarms, central-locking systems and remote garage door openers simultaneously stopped working. Local car dealerships were overwhelmed by calls from angry customers. “We were getting a hundred calls a day,” said Katie Baumann, a service operator at the Ford Country dealership in Henderson, told the Las Vegas Sun. “I tried every button everywhere. I couldn’t get it to lock. I couldn’t get it to unlock,” said Bill Zawistowski, one frustrated motorist. “Nothing I could do would make it work.”

After nearly six months, the riddle of the malfunctioning alarms and central locking systems has this week been solved by two engineers from Ford. The cause turned out to be a faulty “search and rescue” radio signal repeater located 4,000ft up nearby Frenchman Mountain, accessible only by four-wheel-drive vehicle. The radio tower had accidentally started broadcasting at 315MHz, the same frequency used by most remote keyfobs. “The repeater had been stuck on transmit probably since its last use during the winter,” said Maurice Durand, of Ford. “The relatively strong nature of the signal produced interference with many remote entry keyfobs.”

*(Reported by Chris Ayres in Las Vegas, in The Times, Saturday August 24, 2004, page 19, www.the-times.co.uk. This conclusion followed months of fevered speculation that either UFOs or top-secret military experiments at nearby Nellis Air Base – which includes the famous ‘Area 51’military research facility – were to blame, see Roger Franklin’s article “*Case of the mysterious lockout*” in the “Weekend World” section of the New Zealand Weekend Herald, Saturday-Sunday March 6-7 2004, www.nzherald.co.nz.)*

386) LED rear lamps interfere with car radio

For some time now, owners of some lightweight British sports cars with LED rear lights have been posting complaints of interference to their AM radio reception every time they apply the brakes.

While other owners posted helpful comments such as "do not apply the brakes, it slows you down", it was clear there was an EMC issue at the source of the problem. New cars fitted with LED rear light clusters as factory original equipment usually use some form of pulse width modulation (PWM) power control to adjust the brightness of the LEDs. For instance, where the distinction is necessary between night-time rearward illumination and full brightness braking illumination.

It seems to be this PWM control (and associated harmonics) causing the problem in the 100s of kHz region on these sportscars. Some of the manufacturers are now selling owners inductive jump connectors for the wiring loom controlling the rear lights, at £20 for a pair, to suppress this interference.

(Sent in by Alex McKay, by email, 31st July 2006. The editor supposes it is only natural for British sports car drivers to listen to AM radio.)

387) New UK advice on mobile phones in hospitals

Britain’s Medicine and Healthcare products Regulatory Agency (MHRA) has issued a statement on the use of mobile phones in hospital settings. In a departure from long-held conventional wisdom, the Agency does not recommend a blanket ban on mobile phones in hospitals. The statement goes on to say, however, that “under certain circumstances, the electromagnetic interference from a mobile can affect the performance of some medical devices."

The MHRA recommends that hospitals and trusts develop local rules to minimize the risk of interference with critical care equipment, and the Agency has developed two posters that can be displayed for safe use of mobiles. The use of mobile phones is not recommended in critical care areas such as intensive therapy units and special baby care units, or where patients are attached to complex devices.

See the press release on the MHRA website, at: http://www.mhra.gov.uk/home/idcplg?IdcService=SS_GET_PAGE&useSecondary=true&ssDocName=CON2024064&ssTargetNodeId=389.

(From Interference Technology e-news, 28th July 2006, www.interference-technology.com)

388) Solar flares can interfere with GPS, with serious consequences

Solar flares can drown out GPS signals, with potentially serious consequences for airlines, emergency services, and anyone relying on satellite navigation. It turns out that these bursts of charged particles, which produce auroras and geomagnetic storms, also generate radio waves in the 1.2 and 1.6GHz bands used by GPS.

How was such a clash missed? Because GPS receivers only became common during a period of low solar activity. By 2011 solar flares will reach the peak of their cycle and receivers will likely fail. Or so Alessandro Cerruti of Cornell University, New York, told a meeting of the Institute of Navigation in Fort Worth, Texas, last week. The only solution would be to redesign GPS receivers or satellites, which may not be practical, says Cerruti.

(From 'Technology', New Scientist, 7th October 2006, page 27, www.newscientist.com. Cerruti's claims were also reported in 'News', Electronics Weekly, 11th October 2006, page 4, www.electronicsweekly.com. The editor keeps being surprised by how many organisations are using, or planning to use GPS for safety-critical functions, despite its well-known unreliability – reported in numerous previous Banana Skins.)

389) TV blackouts aren't Tetra's fault

I have been following recent correspondence in E&T about the Airwave Tetra System with interest. The interference with television signals that Alan Gordon described in the September issue is not, it seems to me, related to the standard of the installation of the Airwave equipment in police vehicles, nor to its use. Rather, the problem is one of poor immunity of much domestic equipment to out-of-band radio signals.

Lack of immunity is often most obvious where the radio transmissions have an element of amplitude modulation and so Tetra mobiles have the potential to show up this deficiency. The solution is for do domestic equipment to meet the relevant EMC standards. Currently some manufacturers simply ignore the need for proper EMC provisions.

(From 'Feedback', in the IET's Engineering and Technology magazine, October 2006, page 6, www.theiet.org/engtechmag. Also see Banana Skin No. 325.)

390) Microwave ovens interfere with Wi-Fi

Recently, indoor wireless communication systems in the 2.4GHz band, such as IEEE802.11b WLAN (Wireless LAN), are becoming widespread. However, this frequency band is allocated to ISM (Industrial, Scientific, and Medical) equipment. Hence, electromagnetic noises emitted from the ISM equipment may cause interference with WLAN systems. Since there are a tremendous number of microwave ovens for domestic use, oven noises often cause serious performance degradation in WLAN systems.

*(Taken from the Abstract of the paper entitled: "*Reduction of Microwave Oven Interference in DS-SS WLAN Systems using Adaptive Filters*", by M. Nkatsuka et al, EMC-Europe 2004 Symposium, Eindhoven.)*

391) Microwave cooker interferes with Wi-Fi

With reference to Banana Skin No.390, from my own personal experience: I have a wireless LAN at home (IEEE802.11b/g) and also a wireless video sender, to transmit composite video and audio (running in the 2.4GHz band), and also a DECT phone. All of which are happy to cohabit with no problems.

However when I use my microwave cooker, all systems are affected. The wireless LAN on my laptop loses the connection, although it continues to see the router at a good signal level, but is unable to connect. Interference on the video sender makes it completely un-watchable, and a faint crackle can be heard on the phone. This also happens around mealtimes occasionally even when the microwave is not in use, presumably due to neighbours' microwaves? (I live in a terraced house.) My microwave carries a CE mark and is about 7 years old. The microwave is situated about 10 metres away from all the wireless systems. When I come to replace my microwave I intend to complain if the new microwave causes the same interference.

(Sent in by Stuart Nottage of Lambda UK, on Dec 5th 2006, by email)

392) FCC Part 15 unlicensed devices and interference

The Federal Communications Commission's Part 15 rules on unlicensed RF devices and the ways in which possible interference from such wireless systems are addressed have generated an amazing amount of misinformation. Simply reading some of the comments filed by various services on how Part 15 radio devices—specifically WLANs (wireless local area networks)—interfere with their systems might seem to indicate a near-crisis situation.

In responses and conversations, various manufacturers of licensed equipment would have us believe that such Part 15 wireless systems are as beneficent as the Black Plague. However, a thorough examination of the problem indicates that the actual issues are far less troubling—in fact, even manageable.

Yes, interference issues do exist. For example, some of the telecom companies have banned or restricted WLAN devices from their switching stations because their equipment (Part 15 unintentional radiator devices) are subject to interference from WLAN devices. The problem is not the WLAN devices themselves but the fact that the industry immunity standard used in testing these devices does not use "real world" transmitter emissions from a WLAN.

In First Report and Order 01-278, the commission required that radar detectors be certified (they were exempt as a receiver operating over 960 MHz). This action was to avoid a serious field complaint from VSAT (satellite terminal) operators whose services were being disrupted by radar detectors. Occasionally, the FCC has requested that a WISP (wireless Internet service provider) operating Part 15 WLAN equipment cease operation until a specific interference problem has been fixed.

Is the situation perfect? No, far from it, but it is not as chaotic as some people think or, at least, state in their public filings. Apparently, a bit of fear and/or melodrama is being used to advance the case for some complainants.

*(Some extracts taken from "*A look at Part 15 interference problems*", by David A Case, published in Interference Technology's EMC* Directory *&* Design *Guide 2005, http://www.interferencetechnology.com/ArchivedArticles/EMC_Regulations/14_ag_05_web.pdf?regid.)*

393) Interference to broadband services

Response 19.4: A telecommunications company said that Regulation 17 has the effect of meaning that a suspension notice issued under Regulation 44 can only be issued in respect of apparatus placed on the market after 20 July 2009. They are aware of numerous cases of interference to broadband services from apparatus that is faulty or from installations that are poorly maintained. They would like to see suspension 11 notices issued in all cases of interference regardless of age of equipment since there is no other legislation that protects telecommunications networks from this type of interference.

DTI Comments: Regulation 17 has been modified to follow the placing on the market and putting into service provisions of the Directive.

*(Taken from: "*Implementing the new Electromagnetic Compatibility (EMC) Directive in the United Kingdom*", DTI Response to the Public Consultation, December 2006, URN 06/2236, available from http://www.dti.gov.uk/consultations/page28218.html.)*

394) GHz radar pulses can interfere with motor cars

Because of their mobility, vehicles will be placed in many different kinds of Electromagnetic environment. From driving next to transformers and high voltage power lines operating at 50 or 60Hz to driving next to airports where the approaching and landing radars operate at 1.2 to 1.4GHz and 2.7 to 3.1GHz.

Manufacturers of vehicles found some isolated cases where vehicles in the proximity of airports and military bases were affected by the radiated fields from radar systems. The high fields from the radar interfered with the normal operation of critical systems in the vehicle. These systems included braking controls and airbag deployment. Given the importance of the problem the management of vehicle manufacturers applied pressure on the EMC departments to come up with a test plan to check components (what the auto industry often call electronic sub-assemblies, or ESAs – Editor) for electromagnetic immunity to these pulses.

Both Ford Motor Company and General Motors Worldwide introduced sections in their immunity standards for component testing to radar pulses. Generating 600V/m pulses at these frequencies requires the use of high power amplifiers and/or very high gain antennas. In the process of developing antennas optimised to meet these requirements, several issues with the test were discovered. While the test can be done it requires very expensive equipment that is not easily afforded by many small component manufacturers and test houses. As a result of some of the anomalies seen during the testing of the antenna prototypes Ford have made some changes to the tests described in their document.

*(Taken from: "*High Field Radar Frequency Pulse Test for Automotive Components*", V Roderiguez et al, EMC Society of Australia Newsletter, Issue 35, December 2006, www.emcsa.org.au.)*

395) Telecomm globalisation and related interference issues

Some uniformity does exist in the requirements of the POTS (plain-old-telephone-system), at least in how the equipment works. Regulatory standards that the phone equipment must comply with vary from country to country, however. No one knows this fact better than the designers at Silicon Labs. Many years ago, they set out to design a modem that would comply with every standard in the world. Thus, they created the Isomodem line of chips.

The name of one system block of all modems, the DAA (direct-access arrangement), provides a clue to the challenges that designers face. The chips must ultimately interface with the real-world twisted-pair wiring, which can encounter lightning strikes and line-cross events. A line cross occurs when the electric power that is running on the same utility poles as the telephone lines breaks and falls across the phone line. In some regions of the United States those utility poles carry 440V-ac power, and peak voltage is more than 600V. European lines, on the other hand, directly distribute 240V (actually 230V rms, 240V only in the UK – Editor). Nevertheless, the standards for the line-cross event differ all over the world.

In the United States, FCC Part 68 specifies the design limits and testing and requires surge testing at 1500V. In Europe, European standard EN 55024 specifies the limits and does testing at 1000V. Real-world conditions are even more demanding: A line-cross event may generate only a few hundred volts on a phone line, but a lightning strike can far more voltage, and the rise time of that event will be short. Designers at Silicon Labs have seen field voltages of 4500V.

*(Taken from "*Globalisation and Analog*", by Paul* Rako*, EDN Global Report 3, December 2006, http://www.edn.com/community/23439/Global.html.)*

396) Some power quality issues for products marketed worldwide

To compete in the global market, today's analog ICs must address a wide range of application and vo9ltage requirements," says Doug Bailey, vice-president of marketing for Power Integrations. "For example, we know that Japan's ac main can be as low as 90V power, whereas Europe uses 240V (actually 230V rms, 240V only in the UK – Editor). At first blush, this information seems like enough to design a power supply that will operate worldwide. The reality is more difficult. In India, the power grid is unreliable, forcing many big electricity consumers to use private generators during outages.

When the power goes down, and the generators switch in, numerous line spikes occur. When the power grid comes back up, everyone's using generators. The power grid is unloaded, so the voltage can overshoot and ring for several minutes. The resulting surges can go as high as 400V. Products have to be able to handle these extremes, so our application circuits must cover ultra-wide ranges of voltage and help ensure that our chips withstand the spikes.

*(Taken from "*Globalisation and Analog*", by Paul Rako, EDN Global Report 3, December 2006, http://www.edn.com/community/23439/Global.html.)*

397) Experiences of testing aircraft with high intensity radiated fields (HIRF)

During the testing of one aircraft we suffered a very marked and complete electrical failure of the aircraft (much to the alarm of both the test engineers and the cockpit crew) which turned out to be due to the EUT we were testing being next to the ground power supply controller which didn't like the field we were generating. Since this controller would not be in operation in flight its upset was not critical and it had to be shielded using a sheet of RAM (radio absorber material – Editor) when testing continued.

It's not just the aircraft that can be upset. One trial kept setting off the hangar fire-alarms to the point where the fire brigade eventually disabled the system and left one fireman, with a hand-held extinguisher and radio, to act as the building fire-alarm system fort the duration of our testing.

Expect the unexpected – one can often start testing believing nothing is going to happen to the aircraft and be very surprised when it does. When testing a reasonably large (50 seat) turboprop the whole team was caught slightly unawares when it tried to crawl up and over the chocks as our transmissions upset the propeller pitch controller.

*(Taken from: "*Whole Aircraft HIRF Test Experiences: A Practical Viewpoint"*, by Roger Marson, EMC-UK 2006 conference, Newbury, October 17-18 2006, www.compliance-club.com, for a copy of the Proceedings email Pam at pam@nutwoodeu.com.)*

398) Checkout terminal display interferes with radio service, FCC close down the store

A new grocery store had been opened in St Louis, MO. This new "high-tech" (now normal) store included the installation of 15 scanning checkout stands with customer enunciator panels. A week before the big grand opening, store management turned on the new checkout stands to verify their functionality. The function tests carried on the rest of that day and into the next. However, the next morning, a group of men walked in carrying radios and red tags. The checkout stands were red-tagged and turned off. The men left.

The late Chris Kendall (CKC Laboratories) was called in as an EMC Consultant to find out what was happening and to fix the problem. Chris went to work and found the problem right away. The enunciator panels had a display driver at the bottom of the display and there were 5MHz data lines running around one side of the panel and then returned on the other side of the panel. The men who arrived were, of course, from the FCC. They were upset because a local repeater was being jammed (at around 110MHz). The fix introduced by Chris was to tie a wire to the ground path and lay the wire on top of the clock traces as an image return. Once this was done, the interference problem went away, the red tags were removed, and the store opened. The lesson? Remember Mary and her little lamb… everywhere the signal goes, its ground is sure to follow.

*(Taken from "*Who are you guys, and why can't I open my store?*" in "*Chapter Chatter*" by Todd Robinson, IEEE EMC Society Newsletter, Issue 210, Summer 2006, http://www.ewh.ieee.org/soc/emcs/acstrial/newsletters.htm. Todd in turn had extracted this item from a compilation of EMC stories presented several years previously by Patrick André of André Consulting, Inc., at a meeting of the IEEE EMC Society's Seattle Chapter.)*

399) HVAC system interferes with TV

In April of 2004 I installed a new HVAC system to include a Honeywell EAC F300 Electronic Air Cleaner. Immediately, I noticed on channel 9 off-air TV lines of 'snow'. I subsequently found out that the air cleaner was causing this problem. I checked the air-cleaner's electrical power supply outlet, and it is properly wired and grounded. I have both anew ground to the electrical supply panel and the old one to the cold water pipe. I found a reference to a CORCOM EMI filter Honeywell recommends and installed it. I wired up a metal box, wired it in, tested it with my outlet tester, and it worked for about a day. Now, the snow is back. My wife is broadly hinting if I don't fix it she will want either cable or a dish. Anyone have any ideas?

(From Interference Technology e-news, October 5th 2006, www.interferencetechnology.com)

400) If electromagnetic waves can penetrate walls, think what they can do to your skin

A groundbreaking patented protection product that helps prevent accelerated skin aging caused by electromagnetic waves and daily environmental pollution. With Clarins exclusive Magnetic Defence and Anti-Pollution Complexes, this gentle, refreshing mist invisibly shields skin, prolonging youth, health and beauty.

Ingredients: Our Magnetic Defense Complex has Thermus Thermophilus and Rhodiola Rosea, two powerful plant extracts which reinforce the skin's natural barrier and provide biological protection against electromagnetic waves.

(We always try to use an amusing or off-beat item for every 100th Banana Skin. Visit http://us.clarins.com/main.cfm?prodID=826 for more details. Robert Higginson adds (April 6th 2007): Reading what looks like new-age trickery, I put "Thermus Thermophillus" into Google. Some hits include the following.

www.brh.co.jp/en/experience/journal/43/s_library.html (A genuine scientist interested in bacteria which live in high temperatures.)

http://microbewiki.kenyon.edu/index.php/Thermus

www.springerlink.com/content/w53q6qr007v7p428/ (more serious science on these bacteria.)

www.quackometer.net/blog/ (Quackometer !!!) Post for Tuesday, March 20, 2007

http://forums.randi.org/showthread.php?t=76289 (Very entertaining comments.)

www.pocketpicks.co.uk/latest/index.php/2007/03/21/now-with-added-thermus-thermophilus/

http://waitingforlunchtime.blogspot.com/

www.strategymag.com/articles/magazine/20070301/edit.html

We don't think that EM shielding manufacturers need worry about losing customers to Clarins, but if people are really that concerned maybe there's a new market opening up for total-body-covering metallised clothing!)

401) Interference problems with lifts (elevators)

I suppose my two worst 'banana skins' were a shopping centre in Leeds and a big manufacturing company in Germany. The shopping centre was a four car VF (variable frequency motor-drive) group of elevators that had been working fine for 3 years and then blew £3,000 worth of central traffic dispatching computer. I was asked to take a look, spent 3 days on site and found 180 earth faults – which was a shock as this installation had been checked for earth loop impedance at my request and passed with flying colours (this was done by a reputable engineering company we all know).

After another £3,000 worth of kit failed again I went back and to my absolute horror I found the 5" mains riser was terminated to a brand new distribution panel being installed while I was on site. The riser went into a gland plate which sat on a cork gasket, nylon insulation washers and powder coated metalwork – no earth conductor at all.

The problem with this is two-fold: firstly, if we suffered a secondary fault such as a door lock short to earth then the elevator could run with the doors open; secondly, the DC bus rises to 600V on each VF drive and could have proved fatal to the users pushing buttons etc. outside the lift. I can recall running into the electrical contractors office and gripping the chief engineer's lapels – and that's about all I can recall.

The second 'interesting' site was one for a big manufacturing company in Germany. A whole factory the size of a car plant with automated trains and conveyors would 'dump' it's Allen Bradley PLC software, roughly every week. The company spent a fortune sending engineers out to re-program these huge machines for six months.

The problem was that the main control system was fed from a supply the other end of the factory and they didn't want the expense of installing an earth conductor, as one was located next to the control panel. Unfortunately this earth conductor turned out to be the roof lightning conductor connecting to hundreds of square metres of roof lead.

I recall this day very well as it was the Saturday of the Hillsborough disaster, and I spent most of it sitting down watching German electrical contractors dig floors up. Thank goodness it worked. I did receive a few funny comments about the disaster, and I thought if this modification doesn't work I'll be in big trouble. Cross bonding? – none...a long and stressful, but successful trip.

(Sent in by Gary Morgan of Liftstore Ltd, www.liftstore.com, February 2007.)

402) Some more interference problems with lifts (elevators)

I've been doing some EMC training for our customers and one very interesting story came out about a circa 1990's control system with a VF controller. There's a notice on the outside of the controller to say no mobile phones because entering the cubicle with a 3G phone causes both IGBT's to fire at the same time causing a huge bang as two phases join together momentarily before the HRC fuses blow.

All these training days bring out the same stories, you can almost create a tick list for items to check (e.g. a tacho fault will be poor bonding of the trunking runs and pigtails on the screen for the tacho...). From what I can see the two biggest problems are pigtails on the hoist motor terminals combined with poor bonding of the trunking runs.

(Another one from Gary Morgan of Liftstore Ltd, www.liftstore.com, February 2007. Pigtailing cable screens has been deplored by EMC experts and IEC 61000-5-2 for many years – but nevertheless electrical contractors still do it. How long will it take to retrain them all so that fixed installations in Europe stand any chance of complying with 2004/108/EC, as they should from 20th July this year?)

403) Mobile phone masts can interfere with lifts (elevators) in the same building

Mobile phone masts are something that most people do not want erected close to where they live. As a result of this, phone companies will on occasion approach building owners to see if they would lease space within a building to enable a transmission mast to be erected. If its location is out of sight so much the better as residents will be unlikely to know of its existence and will therefore be unlikely to object.

An obvious out of the way place in a lot of buildings is a lift machine room. One LEIA member has recently come across a NHS hospital where a mast had been erected on the roof and the cables and associated equipment have been located in what was the lift machine room. The hospital trust erected a partition wall in the machine room so the equipment was in a separate area. Although when in the machine room the mast and equipment were out of sight, the cables for the mast ran along ducts through the machine room with the lift supply cables. The problem came to light when the lift was found to be developing serious faults in its drive and safety systems. On investigation, it was found that interference was being introduced into the lift equipment though the earth cable route of the transmission device.

There are guidelines for installers of masts for mobile phones base stations but these had not been followed. The most crucial requirements to avoid interference is the separation distances between cables and the separation of earth cables from other common earth points.

There should not be any equipment related to base stations visible in lift machine rooms. The mobile phone base station aerials should be isolated from earth, but the tower structures they are mounted on had to be at zero potential to earth. This has to be achieved by a large cross-sectional conductor, directly connected to the building earth at the main intake. Any part of the base station that has to be earthed is then connected to this common point. However, the common earth point for the base station must not be connected to the building earth at any other point, such as the machine room lighting conduit. It is then that interference is likely to occur.

Problems with base station installation should be referred back to the building owner who should instruct the base station owner to get the issue resolved. It is also important that access routes to machine rooms do not necessitate walking close to transmission equipment.

(Copied from "Are You Aware (25)*", March 2006, a publication of the Lift & Escalator Industry Association (LEIA), www.leia.co.uk. We are not sure how the above instructions fit with lightning protection requirements. We understand that these days the lifts and escalator industry now does reasonable EMC testing of control systems, including testing with the controller cubicle doors open – to simulate what a site engineer would do. The problem is that older equipment has never been EMC tested to any standard and can cause some very strange and even dangerous behaviour. In the case that gave rise to the LEIA advice above, we understand that the circa-1985 drive system for the lift decided to travel in any direction and at any speed, and did indeed trap a number of people on many occasions.)*

404) Household heaters turned on spuriously by interference

The Japanese National Institute of Technology and Evaluation has announced that they have confirmed that some of the household electrical heaters available in Japan malfunction when subjected to electrical disturbances. They conducted the evaluation as a response to the information from consumers that electrical heaters sometimes turned themselves on. They tested thirteen models of heaters for immunity to EFT/B per IEC 61000-4-4. The test results indicated that four of the thirteen samples tested turned themselves on at test level 4 (4kV), and one of them had been caused the malfunction even at test level 1 (0.5kV)!

They also found that two of the thirteen samples could be (unintentionally) controlled by infrared remote controllers for audio/visual products. Fortunately, it seems no fire accidents had been caused – at least at the time of the announcement.

(Sent in by Tomonori ('Tom') Sato, February 2007. Reference: http://www.jiko.nite.go.jp/news/news72.html, in Japanese, 15 November 2006. Tom's website http://homepage3.nifty.com/tsato/ is a great source of EMC information in Japanese. Never trust a software-controlled power switch unless it fully complies with all relevant parts IEC 61508. Also see Banana Skin No. 307.)

405) The EM environment in space 200 nautical miles up

The levels of electromagnetic fields that illuminate a satellite, that originate from earth-based sources, now exceed hundreds of volts per meter (V/m). It is pointed out that the electronic circuitry will have to survive these fields and remain operational as well.

MIL-STD-461E (table 1B) requires a space system to be compatible with high external EME levels of 100V/m from 100MHz-1GHz, but Figure 1 indicates that external fields at 200 nautical miles (nm) height due to earth-based sources such as radio, TV and radars occur out to 100GHz, and up to 250V/m. The field strength at 100 nm will be twice as high.

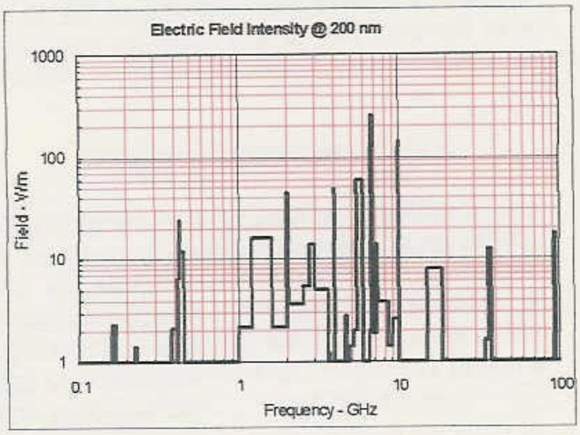


Figure 1, E-field Profile.

In a worst-case scenario these sources might cause damage to the on-board electronic devices.

It is also pointed out that EME can be coupled into a system even if it is not operating. Accordingly, a radiated susceptibility test without power applied would be a prudent step to consider.

*(Extracted from "*Some Simple Spacecraft Considerations*", Edward R Heise and Robert E Heise, IEEE 2006 International EMC Symposium, Portland, OR, USA, August 14-18 2006, ISBN: 1-4244-0294-8/06.*)

406) Interference problems with the NASA Mars Reconnaissance Orbiter

Because of the selected science experiments, the RF communications link, and the limited space for these elements, the MRO spacecraft had greater than usual EMC considerations. Added to that, the late delivery of some of the hardware prevented early identification and resolution of EMC problems. The problems as identified during the test program are identified as follows:

1. The Electra (UHF) receiver was bothered by: SHARAD transmitting, mostly with ELECTRA uncoded, this was an effect that had not been predicted; MCS with its clock on caused ~8-10dB interference; MARCI caused ~3dB interference that had not been predicted.

2. The Shard radar (15-25MHz) was bothered by the C&DH, and its cabling to the power distribution unit and the pyro initiation unit. The basic source was its 24MHz clock, but other frequencies contributed as well.

(Work to resolve these problems was not completely successful in all cases, see the full paper for details - Editor) The spacecraft EMC performance is expected to be adequate for mission needs, but the work to accomplish this status was late, and not as certain as required.

*(Extracted from: "*The EMC Program for NASA's Mars Reconnaissance Orbiter*", Albert Whittlesey et al, IEEE 2006 International EMC Symposium, Portland, OR, USA, August 14-18 2006, ISBN: 1-4244-0294-8/06.)*

407) Power quality problems easily solved at bulk mail centre

The New Jersey International & Bulk Mail Center (NJI-BMC), one of the largest United States postal facilities, recently faced a dilemma regarding its six aging 300kVAR capacitor banks in its three load centers. Initially, we explored the possibility of replacing all capacitor banks on the system, because one of the cans overheated and subsequently failed. But the solution was as simple as turning them off.

Seven months ago, one of the six 300kVAR capacitor cans at the facility developed a bulge. Within a month, we replaced it. At that time, our maintenance crew noticed indicating lights on the other capacitor banks were lit. We presumed the remaining five banks would fail, and thought the simplest remedy would be to replace all six at once. An engineer quoted us approximately $30,000 for replacement, including labor, material, and testing.

A Surprise Solution. At this point, we realized that lower kVA loads coupled with the existing 300kVAR fixed capacitor banks on each side of the facility had caused the overheating and bulging of the capacitor can. Our preliminary calculation indicated the caps were resonating at 7th and 9th harmonics. After testing this load center, we connected power monitoring meters to all remaining load centers. The data revealed the fixed capacitors (if turned on) were creating higher THDs on the system. Later, we learned these fixed cap banks could also damage our supply transformers and equipment. Our solution was to simply turn the cap banks off. By doing this, we prevented a major transformer failure on our system and avoided lost production time.

*(Extracted from "*Bulk Mail Center Avoids Transformer Catastrophe*", EC&M, Jan 1, 2001, by Dilip Pandya, http://www.powerquality.com/mag/power_bulk_mail_center/index.html)*

408) Class D amplifier interferes with AM radio

Russ O'Toole, chasing overheating in a Class D power, amp hung a scope on the output and found several volts in the MHz range. Not surprisingly, it was wiping out much of the AM broadcast band (MW to our European members). The manufacturer didn't think it was a problem. The FCC did, and shut them down.

(From Jim Brown, on the SC-05-05 mailing list, 7 Dec 2006 15:27:43, SC-05-05@standards.aes.org)

409) Rescue robots lose contact due to interference with wireless comms

Plans to send robots equipped with cameras and other sensors into dangerous environments such as burning buildings ahead of human rescue teams could be heading for trouble. More than two-thirds of systems involved in a large-scale trial in the US lost contact with their operators due to radio interference.

Of the 14 types of robot involved in realistic training scenarios, 10 experienced communications problems as a result of interference from other systems. According to the researchers, sticking to industrial, scientific and medical frequency bands designed to minimise interference between different systems is no guarantee of flawless communications between a robot and its operator. *(But that's not what the ISM bands are for! – Editor.)*

Interference was a problem whenever the frequency being used became crowded or when one user had a much higher output than others. For example, transmitters in the 1760MHz band knocked out 2.4GHz video links, while a robot using an 802.11b signal (colloquially known as Wi-Fi) in the 2.4GHz band overwhelmed and cut off another that had been transmitting an analogue signal at 2.414GHz.

NIST has suggest a number of ways of tackling the problem, including changes in frequency co-ordination, transmission protocols, power output, access priority and using relay transformers to increase the range of wireless transmissions. (It sounds as if they could also benefit from some good old-fashioned RF design in their hardware, too! – Ed.) In a paper presented at last month's International Symposium on Advanced Radio Technologies in Boulder, Colorado, they also suggest establishing new access schemes of software-defined radios that improve interoperability.

*(Extracted from: "*Rescue robots hit comms snag*", IET Engineering & technology, April 2007, page 12, www.theiet.org/engtechmag. This item is also mentioned briefly in New Scientist, 10 March 2007, page 25, www.newscientist.com. We should worry about this – military and security agencies are keen to use robots to avoid exposing their operatives to risk, and these robots will be armed and even autonomous – able to decide for themselves what to do. See IEEE Spectrum March 2007 page 12, "*A Robotic Sentry for Koreas' Demilitarized Zone*", www.spectrum@ieee.org.)*

410) ESD interferes with Japanese lifts

On a recent visit to Japan, Dave Imeson, secretary of the very successful and influential EMC Test Laboratories Association (www.emctla.co.uk), was intrigued to find an electrostatic discharge plate installed near every lift button, with instructions to touch the plate to discharge any electrostatic charge before pressing the button to call the lift.

(Conversation during a break in the IET's "EMC and Functional Safety" Working Group meeting on 9th March 2007, London U.K.)

411) Brake failure due to illegally modified transceivers suspected of causing two bus accidents

It has been reported widely in the Japanese press that electromagnetic interference caused by illegally modified transceivers on trucks is suspected of causing two accidents by disabling the braking system of commuter buses.

Mitsubishi Fuso Truck & Bus Corporation announced that two models of its buses are adversely affected by high-powered EMI from short distance and its braking system may not function properly under such conditions. Specifically, its breaking system that detects the wheel-locking condition falsely triggers due to the EMI and thus the brake doesn't work as intended.

Two accidents were reported last year where the bus drivers reported that the brake suddenly stopped working. However, after the police investigation, no visible malfunction was found.

The manufacturer continued investigation and found that high-powered radio signals emitted by a nearby transceiver (illegally modified and thus 1,000-10,000 as strong as permitted by law for such transceivers) can interfere with its braking control unit, resulting in false information that the wheels locked due to braking. Upon this false information, it seems (my interpretation from what I read various reports) that the control unit decided to release the brakes, and thus caused unintended loss of braking.

It is not known whether such illegally modified transceivers were present nearby in two accident cases. But in other two instances where loss of braking was observed, the bus drivers saw suspicious trucks nearby.

The company could reproduce the condition in live experiments, and it will refit the 2200+ cars by replacing the control unit, sensors, pipes, circuit harness, etc. I think the company should be commended for its continued investigation after the accidents.

I have personally noticed voices of presumably truck drivers whose transceiver must have been modified to generate enormous amount of power from my audio equipment over the years. (Remember the CB radio craze of 1970's?) But this is the first time such strong emission is linked to real-world accidents. [I don't think so. We had CB interference knocking out cruise controls long ago. PGN]

The warning that I see and hear on airplanes during landing and take off is no longer a remote worry. I should be glad that most air runways seem to have enough distance from the nearby highway.

As we depend on computers and sensors for better control of *everything* such as cars, home appliances, the malfunctions due to external EMI must be considered carefully, but I suspect that only the military agencies who have tried to harden the fighter planes and such against the EMI caused by nuclear blasts have the technical knowhow or mentality to cope with such problems caused by unusually and possibly illegally high-powered EMI.

(Yes, I know that the FCC regulations and similar usually protect the ordinary home appliances against the run-of-the-mill EMI from computers, etc. However, I doubt that electronic home appliance makers are ready to tackle the above the normal, high-powered emission caused by illegally modified transceivers. And they are a real threat along busy traffic route today. I hate to see various home appliances behave erratically every time a truck with such a transceiver passes by. Or for that matter, a whole field filled with tiny sensors blown by a strong zap of an illegally modified transmitter. Illegal or not, such dangers are going to be real and may have wide-spread consequences in the future.)

cf. The company web page: http://www.mitsubishi-fuso.com

I found the reference to this topic in the Japanese web pages at above URL by following links, but am not sure if English pages have the reference. The Japanese report appears dated 15 Dec 2003, so the translation may have to wait for a few more days.

*(Copied entire from "*Loss of bus braking due to nearby illegally modified transceivers*", The Risks Digest, Volume 23: Issue 9, Tuesday 23 December 2003, posted by Chiaki, ishikawa@yk.rim.or.jp, Sunday, 21 Dec 2003 09:51:41 +0900, brought to our attention by Simon Brown of the Health and Safety Executive, HSE. Current issues of The Risks Digest, which is a 'moderated usegroup' can be read at http:http://catless.ncl.ac.uk/risks. Also see Banana Skin No. 331.)*

412) Car key fob malfunctions – weather – or interference from Wi-Fi hub?

A friend parked her Mitsubishi FTO at our house after a 30-mile drive in pouring rain. When she tried to lock the car, her electronic fob would not work (she could secure the car manually, but was unable to restart without the remote). We called in an emergency service, but it could not solve the problem. Then our neighbour arrived home in his Nissan pick-up and his fob wouldn't work either. This had never happened before. At the same time his wire-free doorbell had been going crazy and had to be disconnected. This made us suspicious, so we carried out a few tests. The key fobs worked on my Ford Mondeo and my neighbour's Range Rover. My neighbour drove his pick-up about 100 yards down the road and the key fob started working again, but when he returned it didn't. We then rolled the Mitsubishi down the road and the key fob duly worked, but it ceased to function once again when she returned to our house. When she left six hours later, the weather had dried and the Mitsubishi fob worked perfectly. What might have caused this?

'Honest John' replies: It was possibly the result of an electrical field conducted by the rainwater. But are you sure no one nearby was using a wireless internet hub?

(From 'Honest John', Telegraph Motoring, Saturday February 10 2007, page M9, www.telegraph.co.uk.)

413) Radio microphone interferes with bingo hall sound system

There is no escape from the climate change debate. Regulars at an Islington bingo hall ("two women of weight – 88") were enjoying a mild flutter when suddenly the fruity tones of The Guardian's George Monbiot came over the loudspeaker with his customary message of doom.

Monbiot was conducting an interview at Greenpeace HQ next door, using a radio mike. No need to interrupt the fun, though – eyes down for a fully-insulated, more climate-friendly house.

*(Roland White, "*Climate change bingo flutter*" in the 'Atticus' column, The Sunday Times, February 11th 2007, page 19, www.sunday-times.co.uk.)*

414) 'First Responder' frequency tests interfere with garage door openers

The Associated Press reports that recent testing by the U.S. Air Force of radio frequencies intended for eventual use by first responders has had the unintended effect of disabling automatic garage door openers in an area near Colorado Springs, CO.

The frequency testing in late November 2006 reportedly took place at the Cheyenne Mountain Air Station, the location of the North American Aerospace Defence Command. The effects from the transmission should technically have been limited an area 15 kilometers from the test site, but Air Force officials suspect that the affected range was extended due to the height of the testing site (nearly 2000 meters).

As a result, hundreds of residents in the area surrounding the Station found their automatic garage door openers suddenly inoperable. One area company reportedly received more than 400 phone calls for assistance in fixing the disabled garage door openers.

Air Force officials are said to be investigating how best to resolve the interference problem, and have discontinued the frequency testing for now.

(Copied entire from Conformity magazine, http://www.conformity.com, Jan 11, 2007, http://www.conformity.com/newsman/publish/printer_370.shtml. Wikipedia, www.wikipedia.org, says: "A certified first responder is a person who has completed forty to sixty hours of training in providing care for medical emergencies. They have more skill than someone who is trained in first aid but are not emergency medical technicians." In the UK they are called the Emergency Services.)

415) Interference with global navigation satellite systems (e.g. GPS)

A new consortium will investigate problems associated with interference, jamming, and multi-path activity affecting the integrity of GNSS applications. Chronos Technology, the National Physical Laboratory (NPL), and Bath University — all of the UK — have formed the Saturn Consortium to better understand the local availability and integrity of GNSS transmissions and the susceptibility or immunity of GNSS applications to external interference.

The Saturn consortium proposes to assess the susceptibility of GNSS applications to external interference and multi-path problems, which all three members have experienced. It aims to develop cost-effective techniques to assess local availability of GNSS transmissions, and to define new standards for Galileo integrity and availability at the point of use.

In a timing environment, local signal authentication will help to improve the efficiency of the new generation of telecommunications and wireless technologies such as TETRA, WCDMA, and Wi-Max, which require precise time synchronization for capacity and bandwidth optimization. Techniques developed by the consortium will be applicable to Galileo as the new system comes into service.

*(Copied entire from: "*Group Forms Over Interference*", GPS World, February 1st, 2007, http://www.gpsworld.com/gpsworld/article/articleDetail.jsp?id=399506, the GPS World homepage is http://www.gpsworld.com/gpsworld. According to http://igscb.jpl.nasa.gov/faqs.html#id2845337, GNSS stands for Global Navigation Satellite System. Currently operating GNSS's are GPS (U.S.A.'s Global Positioning System) and GLONASS (Russia's Global Navigation Satellite System). Another GNSS planned for the future is Europe's Galileo.)*

416) Alarming Microwave

Question: If we use our microwave oven for longer than about 30 seconds, our car's alarm goes off. Why? The car is at least 20 metres away through two walls. The inside of the microwave is a little corroded and the car has a remote central locking/alarm system.

Reply #1: Certain car alarms, such as those fitted to recent Mazda 6, Toyota Rav4 and Mitsubishi Shogun models, transmit a continuous signal at 2.45 gigahertz at powers of up to 500 milliwatts. The microwaves are picked up by sensors inside the vehicle, which detect changes in intensity to signal the presence of intruders. Microwave ovens also operate at 2.45 GHz. While the power radiated within the oven is typically in the range 600 to 800 watts, the amount radiated outside the appliance will typically be less than a watt. When your oven is in operation, the microwaves reaching your car may be powerful enough to trigger the sensors inside it, which the alarm system interprets as a disturbance within the vehicle.

It is possible to set a car alarm so that the internal signal generator is disabled. You might also want to have your microwave oven serviced in case there is a serious leak of radiation. If your microwave has damaged shielding the radiated power could be higher than the values above. (From Joel Smith, Pateley Bridge, North Yorkshire, UK.)

Reply #2: It is odd that your microwave is leaking enough radiation to trigger the car's alarm, considering the legal limit - in the US, at least - for leaked radiation from a microwave oven is 1 milliwatt per square centimetre at a distance of 5 centimetres (*seems a little low – shouldn't that be 1W/sq cm? – Editor*).

Perhaps your microwave has a serious leak, or you have an unusually sensitive car. You could try parking the car in front of a friend's house and running their microwave oven to see what happens. If it appears to be solely your problem, consider getting the microwave replaced. (From Alex Reinhart, Boerne, Texas, US.)

(Copied entire from the 'Last Word', New Scientist, 3 Feb 2007, page 93, http://www.newscientist.com/article/mg19325892.600-alarming-microwave.html. The New Scientist homepage is www.newscientist.com. Also see Banana Skin No. 35.)

417) Mains harmonic distortion from electronic equipment upsets energy providers

The increasing use of electronic equipment is causing 'harmonic distortion' on the UK supply network. This is caused by non-linear loads on the electricity supply system, such as PCs, lighting systems, switch mode power supplies and variable speed drives.

Regulation ER G5/4-1, published by the energy networks association (ENA) is the UK's instrument to control this distortion and to assist compliance with the harmonised network standards such as EN 50160. ER G5/4-1, which was first published in 2001 and subsequently updated in November 2005, is the UK's attempt to control harmonic distortion back onto the supply network and is the updated version of the earlier G5/3 which was published in 1976. Ironically, many of those affected by power quality issues remain unaware of the original regulation, let alone the updated version.

I have personal experience of a number of installations where compliance issues have been tackled badly and the remedial measures have more costly than early preventative considerations. A £50k investment in preventative measures, for example, for example, could have saved a small food and beverage company in the North of England around £1m which they subsequently had to spend on mandatory remedial issues.

One example, in the food and beverage industry, concerns a soft drinks company which was inadvertently creating power quality issues onto the local 1kV supply network and causing domestic lighting in the area to flicker uncontrollably. The first the company knew of this problem was a visit from its electricity supplier threatening to cut them off!

*(Extracted from "*The Hidden Cost*", Steve Barker, IET Computing and Control Engineering, February/March 2007, pp10-11, www.theiet.org. Other very similar articles by Steve Barker on the same subject (compliance with G5/4-1) and containing the same examples include: "*The Hidden Cost of Power Quality Problems*", Electrical Engineering, February 2007, pp 36-37, http://www.connectingindustry.com, and "*Industry Vulnerable to Hidden Power Costs*", Electrical Review, Vol. 240 No. 3, pp 10-12, www.electricalreview.co.uk.)*

418) Crocs slippers can cause ESD interference to hospital equipment

A hospital in Sweden has banned workers from wearing ‘Crocs’ slippers after learning the popular footwear can build up static electricity.

After officials at the Blekinge Hospital in Karlkrona determined the comfortable shoes built up so much static electricity they interfered with medical equipment they decided to ban the offending footwear, The Local reported Wednesday.

The fashion statement-turned-medical problem began in February when a two pieces of respiratory equipment for premature babies shut off for no discernable reason.

Eventually the machines' mysterious power outage was linked to the plastic slippers that many staff members wore on duty and the ban was suggested.

"Everybody generates static electricity. But it usually loses its charge, either by disappearing through one's shoes or elsewhere," said Bjorn Lofqvist, a spokesman for the hospital.

The Local said the slippers were found to be capable of becoming charged with a maximum electrical charge of 25,000 volts.

*(Copied entire from “*Insulating slippers have shocked hospital*”, NewsTrack – Quirks, United Press International, UPI, April 19, 2007 12:28 AM http://www.upi.com/NewsTrack/Quirks/2007/04/18/insulating_slippers_have_shocked_hospital, sent in by Paul Bertalan of Sensis Coporation on 19th April 2007.)*

419) Portable transmitters could interfere with control of nuclear power plants

Although the power output from handheld RF devices is generally limited to a maximum of 7 watts because of RADHAZ safety constraints, their portability makes them particularly troublesome. As illustrated in Table 2, the higher power hand held devices can easily create electric field levels over 20 V/m. Tests performed by Oak Ridge National Laboratories (ORNL) summarized in Figure 3 indicated that approximately 50% of electronic devices are susceptible to EF levels in the amplitude range from 20 to 50 V/m. Devices tested were predominantly non-RF solid state analogue control systems used in Nuclear Power Plants.

Although operational controls exist for these handheld type emitters, the number of people who carry these devices is great so relying completely on operational constraints in the handheld frequency range is a risk.

*(Extracted from “*Modern Spacecraft – Antique Specifications*”, Ron Brewer, Launch Service Program, Analex Corporation, IEEE International Symposium on EMC, Portland, OR, USA, August 14-18 2006, ISBN: 1-4244-0294-8/06.)*

420) Powerful solar bursts interfered with GPS in December 2006

The National Oceanic and Atmospheric Administration (NOAA) reports that a solar eruption last December affected global positioning systems (GPS) and other technologies using radio waves. That conclusion, based on findings by researchers at Cornell University, were announced on April 4, 2007 at the first Space Weather Enterprise Forum in Washington, DC. This group of academic, governmental, and private sector scientists are examining Earth’s ever-increasing vulnerability to space weather impacts.

Forecasters from the NOAA Space Environment Center in Boulder, CO observed two powerful solar flares on December 5 and 6, 2006. These violent eruptions originated from a large sunspot cluster. On December 6, a solar flare created an unprecedented intense solar radio burst causing large numbers of receivers to stop tracking the GPS signal.

“The solar radio burst occurred during the solar minimum, yet produced as much as 10 times more radio noise than the previous record,” according to Dale Gary, Ph.D. of the physics department at the New Jersey Institute of Technology. “Measurements with NJIT’s solar radio telescope confirmed that, at its peak, the burst produced 20,000 times more radio emission than the rest of the sun. This was enough to swamp GPS receivers over the entire sunlit side of the Earth.”

For more details on these findings, go to the NOAA website: http://www.noaanews.noaa.gov/stories2007/s2831.htm

*(Copied entire from: “*Powerful Solar Bursts Affected GPS Systems in December*”, Interference Technology News, April 20 2007, www.interferencetechnology.com. Also see Banana Skin No. 388, which predicted this problem. Why are so many organisations planning to rely on GPS for safety-*

critical systems? A quick search through 'Banana Skins' should show them what an unreliable system it is.)

421) Spacecraft interference experiences from Mark Simpson

- Programs that cut corners usually cut too many and run into serious trouble with interference
- Checklists are very helpful in preventing missing following one or more good EMC design rules
- Most interference problems that have occurred could have been caught by using highly skilled and experienced engineers
- Many engineers have experience limited to a handful of programs, and most problems occur when an engineer works on a program with more stringent and complex requirements than they are familiar with
- Most programs use requirements and units from last program: 'Built to boilerplate', hope it works, test and patch when it inevitably doesn't work
- Heritage (legacy) claims of 'no problems' are almost always wrong – only a small percentage of problems make it back to current program people (*This approach is sometimes called 'proven in use – Editor*)
- Some failures have been serious, e.g. transmitters jamming sensors; jammed command receivers; premature deployment; failure to deploy
- Over the past 12 years, 7 programs have each taken more than a year to fix their interference problems
- Most programs have operational problems caused by interference
- ESD from spacecraft charging continues to plague programs – sometimes only discovered after several vehicles have been launched
- One program had to be cancelled due to EMI
- A payload had to be turned off because it caused massive interference
- I have personally saved several programs from complete mission loss due to interference problems
- Independent EMC oversight saves programs
- Using my 'lessons learned' will help you save your program

*(From "*Speaking the Unspeakable: The Role of Independent Oversight*", Mark Simpson, presented at the Workshop session on "*Aerospace EMC at the Centennial of Flight*", IEEE 2004 International EMC Symposium, Santa Clara, CA, August 2004,ISBN (CD-ROM) 0-7803-8444-X, IEEE reference: 04CH37559C .)*

422) ECG susceptibility to Gameboy™, iPod Nano™, cellphones, etc.

This experiment investigates the susceptibility of an ECG machine to emissions from unintentional emitters such as Gameboy™, iPod Nano™, and intentional emitters such as a Cell Phone, Portable 2.4GHz Phone, Portable 5.8GHz Phone, and walkie-talkie. Experiments were conducted both in a "lab" and hospital environments. The authors demonstrate that all of the above popular electronic devices can interfere with an electrocardiogram (ECG) and corrupt the readings.

Heartbeat changes ranging from 14 to 28 beats per minute were recorded due to EMI from these devices. Although doctors and Medical Technicians have been alerted to the possibility of interference from intentional emitters, they are generally unaware that popular unintentional emitters can corrupt their equipment. These results clearly illustrate the need for including both intentional and unintentional emitters in the EMI control of hospitals, medical offices and home care environments.

Home care is becoming more and more common, and people are relying on medical equipment for either monitoring, medicating or relieving medical conditions. Generally people are not aware of the possibility that popular electronic devices can interfere with their medical equipment. Patients are generally not warned which home equipment should, or should not, be used in proximity of the medical device. In the home setting EMI from many intentional and unintentional emitters can result in faulty operation of the medical device and possibly lead to grave consequences for the home care patient.

According to the signage in the hospitals we have visited, iPods™, Gameboys™ and even the Gameboy™ Advance DS (with wireless) are not banned. Especially in a Childrens' Hospital kids will play with these games or listen to their iPod™ to pass the time while undergoing lengthy tests and procedures. Air Lines know that these devices should not be used during critical operations. Now we are proving that the same applies to Hospitals, Home Care and Doctor's Offices.

*(Extracted from "*Electrocardiogram (ECG) Susceptibility to Interference from Popular Electronic Devices*", Matthew Pinchuk Meland and Anthony Dedes, IEEE EMC Society Newsletter, Winter 2007 (they mean Winter 2006!), Issue 212, pages 64-66, www.emcs.org. Also see: http://uk.reuters.com/article/technologyNews/idUKN1048845320070510 and Conformity, July 26 2007, www.conformity.com.)*

423) Interference causes poisoning of patient

European medical device regulations state mandatory limits at a distance of 10m, these measurements are performed in far field conditions. However, in many medical scenarios it is difficult to avoid the presence of EMI sources too close to sensitive equipment, and this situation is not covered by the standards.

Regarding the EMI that are not coming from medical devices, a typical situation is the use of a mobile phone inside medical facilities. There are several reports about medical problems attributed to the use of a mobile phone near a medical device: Hann in [4] reports the poisoning of a patient by an overdose of epinephrine prompted by the malfunction of an infusion pump due to a cellular phone call received by a family member.

[4] In-Hei Hahn, David Schnadower, Richard J Dakin and Lewis S. Nelson "*Cellular phone interference as a cause of acute epinephrine poisoning*" Annals of Emergency Medicine, Volume 46, no. 3: September 2005. pp 298-299.

*(Extracts from "*Medical Equipment Immunity Assessment by Time Domain Analysis*", Mireya Fernández-Chimeno, Miguel Ángel García-González and Ferran Silva, 2007 IEEE International Symposium on Electromagnetic Compatibility, 8-13 July 2007, Honolulu, Hawaii, ISBN: 1-4244-1350-8, IEEE EMC Society: http://www.ewh.ieee.org/soc/emcs.)*

424) Modern spacecraft – Antique specifications

Spacecraft now and of the future are being controlled by EMC requirements of the past. Little has been done by the launch vehicle/spacecraft manufacturers to abandon MIL-STD-461C which was released in 1986 because most of the electronics equipment being used aboard current launch vehicles is approved by similarity and heritage to MIL-STD-461C and its predecessors. Twenty years later these electronic equipment items are still not tested to today's MIL-STD-461E requirements because there is a risk that the items will fail to meet the requirements and thus the cost will increase if it becomes necessary to redesign the equipment. That cost is insignificant compared with the cost of losing an entire mission!

In the 20 years that have elapsed since MIL-STD-461C was released, the EMC environment has undergone major changes. High speed digital devices have been created that have fundamental clock and bus frequencies that span the entire LV/SC frequency range from the UHF Band Flight Termination Systems through S-Band telemetry and C-Band tracking transponders. Personnel involved in ground operations can carry and use hand held transceivers and cellular telephones close by sensitive electronics equipment. There are now many more orbiting receivers and emitters, plus range assets have increased dramatically since 2001. It's way past time to bring requirements up-to-date!

It is important to note that daily KSC (Kennedy Space Center) monitoring has detected levels from off site emitters that are theoretically beyond the horizon and at times detected levels higher than the theoretical free space maximum. This is possibly due to multipath and atmospheric ducting effects.

The vehicle may fly closer to an emitter during launch and thus be exposed to higher field levels than it is exposed to on the launch pad. There are also downrange emitters that can cause strong fields at the vehicle. In this case the trajectory of the vehicle must be considered. Data bases that are developed by the Joint Spectrum Center are used to determine these levels. The Launch Services Program has recently funded Aerospace to predict ascent field levels for each mission based on the flight trajectory.

In addition, once the spacecraft separates from the vehicle the on-orbit fields must be considered if it will be in a near earth orbit. It is common for tracking radars to use spacecraft as targets of opportunity and field levels from both US and other emitters can be as high as 100's of volts/meter. Additionally there are other extremely high level emitters (over the horizon back scatter RADAR, etc.) that produce levels in the 1000's of V/m that SC trajectories may inadvertently cross. Table 3 shows the worst case ascent and on-orbit field levels being specified in the proposed MIL-STD- 1541B. Some of the emitters reflected in this table such as Cband tracking radars are mitigated, however some can not be, especially foreign emitters.

TABLE 3. SUGGESTED RF SUSCEPTIBILITY LEVELS

AEROSPACE RPT TOR-2005(8583)-1 Table 6.16c1-1. RFI Susceptibility Verification Levels (V/m) for worst case (Polar) Orbit, Any Launch Area

Frequency Hz	Factory/Transport Launch Proc/Pad	Ascent	On-Orbit 100 nmi	On-orbit 500 km	On-Orbit 1000 nmi
10k – 1.99M	25[1*], 20[2,3]	20[2,3]	20[2,3]	20[2,3]	20[2,3]
2 – 99M	50[1], 20[2,3]	20[2,3]	20[2,3]	20[2,3]	20[2,3]
100 – 999M	100[2], 1500[1]	100[2], 1500[1]	50[4], 40[5], 100[2]	20[3,4], 100[2]	20[3,4], 100[2]
1 – 3.99G	250[6], 200[2], 2500[1]	200[2], 2500[1]	190[4], 100[5], 200[2]	70[4], 40[5], 200[2]	20[3,4], 200[2]
4 – 10.99G	1000[7], 2500[1], 44000[8]	1000[7], 2500[1]	500[4], 120[5], 200[2]	200[4], 50[5], 200[2]	50[4], 20[3,5], 200[2]
11 – 40G	50[9], 1500[1]	20[2,3], 1500[1]	70[4]	30[4]	20[2,3]

*Superscripts 1 – 9 refer to notes in AEROSPACE RPT TOR-2005(8583)-1

BOLD EF levels are the recommended design and verification levels for LV/SC

*(Extracts from: "*Modern Spacecraft – Antique Specifications*", Ron Brewer, Launch Service Program, Analex Corporation, IEEE International Symposium on EMC, Portland, OR, USA, August 14-18 2006, ISBN: 1-4244-0294-8/06.)*

425) Equipotential design of systems

Using the original concept, the system failed for EFT testing at 1kV in a capacitive coupling clamp. The reason was that the distributed control units and the central screen were connected using screened cables, but the screen was terminated at both ends by a pigtail connection. By changing the screen termination into a low impedance connection, mounted directly at the chassis entrance of the modules, the EFT test passed up to 5kV.

The failure of temperature sensors has been found many times in practice, always with similar reasons of failing: no good equipotential reference over the complete system. Typical for a set of sensors and transducers is the fact that they are very distributed over larger systems. Because in some cases the termination at both ends of a screened cable causes problems, the screen is not terminated at all, or only at one side. Which does not really offer a good protection at common mode level of interference, and certainly no more at higher frequencies of the ambient noise.

Most of the problems are occurring because subparts of a larger system are not well interconnected. In this case, the problem can be solved by 'insulating' the sensor itself (ex. by using optocoupled systems, or differential mode signal transmission), and by connecting the screen of the cable in a good way to the chassis as the incoming point of the central control unit. For safety reasons, special care must be taken for PE requirements, ending sometimes in an extra (parallel to the cable screen) PE wire connection.

*(Extracts from: "*Equipotential Design of Systems: Examples from Practicing*", J Catrysse, W Debaets, N Dediene, EMC Europe 2000, 4th European Symposium on EMC, Technologisch Instituut vzw, Brugge, 11-15 Sept 2000, ISBN: 90-76019-14-2.)*

426) Failures at electricity distribution substation

This study into disconnector-related EMI was initiated following series of failures experienced at Brenner substation – an Eskom 275/88kV open-air substation situated in Gauteng, South Africa. In particular it was noticed that Bandwidth Management Equipment (BME) installed in a cabinet inside the substation's telecommunications room would fail for a period of approximately 10 seconds each time disconnectors were operated in an adjacent high voltage yard [2].

The BME is a crucial part of the microwave communications link between the site and the National Control master station, and it takes 20 – 30 seconds to re-establish this link if the BME fails. Another cause for concern was that the BME occasionally failed during line faults [2].

(*Extracted from: "*Testing Hypotheses Concerning the Flow of Common Mode Current in a Substation*", CD Walliser, JM Van Coller, PH Pretorius and AC Britten, EMC Europe 2000, 4th European Symposium on EMC, Technologisch Instituut vzw, Brugge, 11-15 Sept 2000, ISBN: 90-76019-14-2.)*

427) Patriot missile system interference

The Wall Street Journal reports that military investigators are exploring the possibility the electromagnetic interference may have been the cause of two friendly fire incidents during the Iraq war involving Patriot missiles that resulted in downing of two allied fighters and the deaths of three airmen.

According to the Journal report, investigators have ruled out either manual error by the operators of the Patriot missile batteries, or mistakes by the missiles themselves, and are now focusing on whether the extremely close positioning of multiple missile batteries on the ground resulted in elevated levels of EMI that interfered with the systems' high-powered radars.

Military officials admit that the Patriot missile batteries were moved around the battlefield during the war to protect U.S. and British ground troops, and at times were clustered in close proximity to one another. And, although all military systems are tested for EMI, the Journal quotes one source who said: "If you look at the intensity of the radiation in that battlefield area, I don't believe anyone would say that particular environment had been duplicated before. It was very, very intense."

*(Extracts from "*Patriot Missile Systems may be EMI Susceptible*", NEWSbreaks, Conformity, September 2003, page 48, www.conformity.com. Also see Banana Skin No. 299.)*

428) Pilots pick up baby monitor transmissions

CNN reports that pilots approaching Luton airport in Great Britain recently picked up more than the monotone of the air traffic controller over their radios. Authorities reportedly worked 12 hours to track down the sound of a squealing infant that was picked up on the normal communications frequencies. They ultimately traced the noise to a baby monitor in a home located near the airport. Broadcasting babies aren't new. As we've previously reported (See Conformity, October 1997), or own Federal Aviation Administration receives numerous reports of similar incidents here in the United States as wireless communications devices proliferate.

*(Extracts from: "*Pilots pick up Baby Monitor Transmissions*", NEWSbreaks, Conformity, August 2003, page 88, www.conformity.com. Also see Banana Skins No. 225 and 299.)*

429) Interference with critical auto systems

One car manufacturer found that the craze for CB radio caused more than a jamming of the airwaves. They found that if a CB was operated in close proximity to their car, the central locking engaged, locking the passengers within the vehicle! On a slightly more serious note, another prestige car manufacturer found that whenever the vehicle passed by an operating ambulance or fire station, the air bags activated.

*(Extract from "*Critical Nature of EMC*", Schaffner, Components in Electronics, May 2000, page 22, www.cieonline.co.uk.)*

430) Mobile threat to drivers

Mobile phone makers and car manufacturers are investigating claims that handsets can cause car safety airbags to inflate and interfere with automatic braking systems. Test carried out by Volvo in Sweden found that phones operating independently of car electrics can trigger airbags and interfere momentarily with control systems.

(*Extracts from: "*Mobile Threat to Drivers*", Computer Weekly, August 12 1993, Page 1)*

431) Interference examples from 1996

- A semi-submersible oil exploration platform moving off-station when its global positioning by satellite system was disrupted by the signal from a portable radio. This was due to poor shielding on an interconnection cable.
- Police cars' central locking systems operating during use of their mobile radios.
- Vehicle anti-lock braking devices operating when a radio transmitter beaming across a highway five miles away, was used.
- A fatality when electromagnetic interference (EMI) caused a computer-controlled crane to drop its load.
- Two fatalities when robots went out of control in a factory.

- Failure of a portable gas detector, monitoring toxic gases while personnel repaired a sewer, when a hand-portable radio was used near it.
- Proximity devices operating due to EMI.
- A train operated abnormally when its rear locomotive developed a computer fault which caused it to be affected by radio emissions as it passed an airport (18th September 1995, 06:45, Birmingham New Street to London Euston).
- A ladle making an incorrect stroke and burning a die-casting machine operator, possibly caused by EMI.
- A radio controlled crane going out of control, possibly due to EMI.
- An electron beam welding machine interfering with radio transmissions.
- A computer-aided drawing system malfunctioning because of electric trains three miles away.
- A hydraulic pump in a nearby building causing errors in a tensile testing machine.
- An expensive process shutting down due to the use of an X-ray techniques in a nearby building site to monitor the quality of welded pipes.
- Nearby fluorescent luminaires affecting the operation of radio receiving equipment.
- A PC network regularly 'crashed' at dusk, found to be due to the switching on of nearby fluorescent street lighting.
- 'And then there was the North Sea oil platform whose IT systems crashed on random occasions throughout the day for no apparent reason. The problem there was identified as visiting helicopters, the rotor blades of which were acting as giant Van Der Graff generators, accumulating enormous static charges that were discharged on landing.'[11]

*(Extracts from "*Coping with the EMC Regulations*", P Ridley, IEE Engineering Management Journal, April 1006, page 101. Some of these incidents have also been reported by others in other Banana Skins.)*

432) Pacemakers unaffected by stun guns

According to a study carried out by the Cleveland Clinic and published in Eurospace by the European Society of Cardiology®, a standard electrical discharge from a TASER® X26 electronic control device or stun gun, does not affect the integrity of implantable pacemakers and defibrillators and did not trigger an implanted cardioverter difibrillator (ICD) shock in devices programmed to the standard non-committed shock delivery mode.

The impact of electromagnetic interference on cardiac devices has been a long-standing concern and, in some instances, has been known to cause damage to internal circuitry, over-sensing, under-sensing, failure to pace, failure to capture, triggering of elective placement indictors, and inappropriate defibrillation shocks.

(*Extracts from: "Study:* Pacemakers Unaffected by Energy from Stun Guns*", EMC News, Interference Technology, May 2007, www.interferencetechnology.com.)*

433) Voltage disturbance problems with paper mill

The paper machine process requires precise control of the paper sheet tension as it progresses through the machine. On Caledonian Paper's paper machine this is achieved by controlling 23 separate DC variable speed drives, which are inherently vulnerable to voltage disturbances because of problems with the control of thyristor firing.

Firing angle control has difficulty following the voltage change, with possible consequential damage to thyristors. To prevent this damage, it is common for drives to be equipped with protection that trips the drive, using settings dependent on the drive's sensitivity to voltage disturbances, The manufacturers designed Caledonian Paper's drives at 90%, so that disturbances below this level for more than a few cycles caused a trip.

It was confirmed that the paper machine could be affected by voltage disturbances of only 10% variation from normal (90% retained) and as for as little as 100ms. Some events, which have affected production, only just come into the classification of a voltage dip, as described in the European Standard EN 51060, and the severity of events which cause disruption is not severe when compared with all possible disturbance events under equipment testing specifications, as described in IEC standard 1000-4-11 (now IEC 61000-4-11 – Editor). However, as a result of the voltage disturbance and associated DC drive trip, the paper machine suddenly stops in an uncontrolled manner with the potential for extensive damage particularly, in the wire and press sections.

The possibilities of damage and extensive downtime are greatest within the paper machine but disturbances can also affect the rest of the mill with activities downstream from the paper machine, such as the coater, supercalandars, and ancillary equipment suffering to varying but lesser degrees. The situation can also be exacerbated by having multiple incidents in a relatively short timeframe, e.g. a number of events over one day, especially when followed by a succession of disturbances over a period of several days.

(*Extracted from "*Special Feature: Electrical energy storage*", IEE Power Engineering Journal, June 1999, pages 154 and 155.)*

434) Wendy's restaurant interferes with satellite system

The FCC's Kansas City office received a complaint that the Search and Research Satellite Aided Tracking (SARSAT) system was experiencing interference from an unknown source. SARSAT is used by search-and-rescue teams to locate the radio beacon transmitters of crashed aircraft and distressed ships. Using mobile direction-finding gear, the FCC tracked the interference to a (presumably malfunctioning!) video display unit at a Wendy's restaurant.

(From "FCC's CIB Fight Interference", Newswatch…EMC, Compliance Engineering European Edition, September/October 1995, page 8, www.ce-mag.com.)

435) Cellphone interferes with ECG

Trigano et al, in [5] report an electrocardiogram recorded during 1800 MHz cellular phone ringing with high amplitude and high-frequency artefacts that appears 3 seconds before the first ringing tone and that persisted until end of ringing. As consequence of these facts many hospitals have prohibited the use of cellular phones in some areas.

[5] Alexandre Trigano, Olivier Blandeau, Christian Dale, Man-Faï Wong and Joe Wiart "Risk of cellular phone interference with an implantable loop recorder" International Journal of Cardiology, In Press.

*(Taken from "*Medical Equipment Immunity Assessment by Time Domain Analysis*", Mireya Fernández-Chimeno, Miguel Ángel García-González and Ferran Silva, 2007 IEEE International Symposium on Electromagnetic Compatibility, 8-13 July 2007, Honolulu, Hawaii, ISBN: 1-4244-1350-8, IEEE EMC Society: http://www.ewh.ieee.org/soc/emcs)*

436) Safety while swimming in a sea of electromagnetic energy

In this issue of Mayo Clinic Proceedings, 3 articles bring the issue of exposure to electrical transmissions and patient safety to the forefront. Tri et al1 report on their investigation of possible cell telephone interference with medical equipment in a hospital setting. Gimbel and Cox2 provide a report of 2 patients with implantable cardioverter defibrillators (ICD) who had adverse interactions with electromagnetic scanning devices in their community. Finally, Austin et al3 report on a person whose consumer electronic device interfered with an electrocardiogram (ECG) and led to an initial misdiagnosis of atrial flutter.

The current investigation by Tri et al1 is a follow-up to their previous 2005 in vitro report.4 In their earlier research, the authors discovered that cell phones produced interference in 44% of the tested devices, although the incidence of clinically important interference was only 1.2%. Older analog cell telephones that emit a relatively high-energy signal produced the most interference. Cell telephones had to be placed fairly close to the tested device (ie, <33 in) to produce any interference. Cell telephones were less likely to cause interference in newer medical technology. The authors concluded in 2005 that technologic advances had improved the resistance of medical devices to interference from cell telephones, but that the type and number of electronic designs were anticipated to steadily change, necessitating ongoing testing.

Tri et al heeded their own advice and tested newer technology, using a study design more relevant to daily patient care. Specifically, in the current 2007 report, they investigated cell telephone and wireless handheld device (Blackberry, Research In Motion, Waterloo, Ontario) interference of medical equipment while the equipment was being used on hospitalized patients, including those in intensive care units. The tested medical equipment was both diagnostic and therapeutic (e.g. physiologic monitors, infusion pumps, mechanical ventilators). The authors performed 300 tests of cell telephone interference and 40 tests of wireless handheld device interference. They found no interference with any of the tested medical technology. The authors concluded that institutions should consider revising hospital policies that restrict cell telephones.

In contrast, Gimbel and Cox reported on 2 patients having ICD devices that were triggered by electronic article surveillance (EAS) systems (ie, electronic devices placed at store exits to detect stolen merchandise). In both cases, the patient had relatively close contact with an EAS device at a retail store exit. In one case, when the patient collapsed after being shocked, an employee propped the patient against the EAS pedestal, thereby triggering further shocks. In both cases, the patients had ICDs from the same manufacturer. Austin et al reported on a similar but less dramatic electrical interference event. A healthy volunteer had an ECG recorded as part of an extra-hospital drug study. The ECG was read as atrial flutter with an atrial rate of 333/min. It was discovered that the volunteer had a portable compact disk (CD) player (Walkman, Sony Corp, Tokyo, Japan) close to the right-arm lead of the ECG. When the CD player was turned off, the ECG recording returned to normal sinus rhythm (also see Banana Skin number 422 – Editor).

(*Extracts from: "*Safety while Swimming in a Sea of Energy*", Editorial, Mayo Clinic Proceedings, March 2007, Volume 82, Number 3, pages 276-277, www.mayoclinicproceddings.com.)*

437) Financial costs of delayed EMC compliance

A manufacturer of electrical test equipment took an order worth several million dollars for new product to be used worldwide to help service the vehicles manufactured by a major multinational. It failed to meet the EMC standards required for compliance (which had also been made a part of the contract).

Testing and consultancy to discover the causes and find do-able fixes for the EMC problems (several low-cost options not being possible due to the late stage of the project) cost around $20,000; iterating the PCBs to a compliant build standard cost around $60,000; and refurbishing non-compliant units already supplied to the customer cost around a further $70,000.

The delivery of the (eventually) EMC-compliant units was also delayed by five months from the target date, causing equivalent delays in receiving the first payments and incurring greater costs of financing the project (by putting the financial break-even point back around half a year on what was intended to be an 18 month project). Whether any harm has been done to the test equipment manufacturer's reputation with their customer, or with the marketplace as a whole, remains to be seen.

(A contribution in June 1999, the source wishes to remain anonymous.)

438) Pump at ski resort causes interference

In 1996, a ski resort near Silverthorne, Colo, installed a pumping system to lift water up to a river, whose water flows into a lake at the base of the resort and is then used on the mountain for snowmaking. At that time, the pumping system consisted of a 350-hp, 480VAC, 3-phase, SCR, variable-frequency drive (VFD), which was located at the base village. Because the pump and motor were positioned 900 feet below the river and VFD, the resort used 4,1560V as the distribution voltage from the VFD to the motor and pump. The power source for the pumping system was, and still is, a 1000kVA transformer fed by a 25kV, 3-phase overhead power line located five miles from the ski resort. This line also runs beyond the pumping system and serves a local community.

This pumping system worked well for several years with only the 350-hp pump, but as the ski resort expanded its snowmaking system, more water was needed. As a result, a 750-hp VFD, pump, motor and new pipe to the river were installed in 2002. At this point some real operational problems surfaced.

During the 2002-03 ski season, the resort could not run the 750-hp VFD at full capacity by itself, let alone together with the 350-hp VFD running at full capacity. The drives would drop off-line because of their under-voltage protection. Another concern was that homeowners and businesses in the area and nearby community complained of flickering lights.

(*Extracted from: "*Solving a Power System Compatibility Problem*", Vaughn DeCrausaz, EC&M, June 1st 2006, http://ecmweb.com/powerquality/electric_solving_power_system/index.html. The rest of the article describes how the problem was solved with careful measurement and the application of reactive power factor correction to achieve a unity power factor for the VFD systems.)*

439) Electric 'bum' hazards

I've been reading up on various standards relating to test equipment safety and stumbled across BS EN 50110-1 1996 section 3.1.6 Injury (electrical) which cites "electric bum" as a potential hazard! I zoomed in and re-read it several times, it's definitely B U M and not B U R N.

'Electric bum' sounds quite painful, I'm definitely taking all the necessary precautions to avoid that one!

(Sent in by James Toddington of BAE Systems Electronics & Integrated Solutions, Rochester, 9th May 2007.)

440) Switching of power-factor correction capacitor interferes with contactor

A case study illustrates negative impulses of 366V followed by positive impulses of 420V at the terminals of a LV load when a power factor correction capacitor was switched on within an adjacent installation. These transients caused a contactor within a switch panel to fail to latch correctly.

*(From subclause 9.2 of IEC/TR 61000-2-14:2006,"*Environment – Overvoltages on public electricity distribution networks*", Clause 9: "Case Studies", www.iec.ch)*

441) Interference from insulation breakdown caused by vibration

This case study shows how high levels of vibration in a three-phase induction motor could cause insulation breakdowns causing momentary earth-faults on one phase. The resulting short voltage peaks on the mains distribution networks caused frequent misoperation of electronic regulators.

(From subclause 9.3 of IEC/TR 61000-2-14:2006,"Environment – Overvoltages on public electricity distribution networks"*, Clause 9: "Case Studies", www.iec.ch)*

442) Switching MV power factor correction trips LV circuit breaker

This case study concerns frequent operation on a circuit breaker protecting a PVC moulding plant, causing lost production. It was found that the cause was the switching of a 120kV power factor correction capacitor in the upstream substation.

(*From subclause 9.4 of IEC/TR 61000-2-14:2006,*"Environment – Overvoltages on public electricity distribution networks"*, Clause 9: "Case Studies", www.iec.ch)*

443) Wireless interference problems in the home

Take a look at any Sunday newspaper's advertising section for stores that sell electronics, and it is clear that wireless devices are everywhere. Visit these stores and listen to the salespeople selling wireless local-area-networks (WLANs), cordless phones, and all else wireless to often-naïve consumers.

What salespeople fail to tell consumers is that before consumers buy the latest wireless gadget, they should make sure that it will function properly in their home environment. For an unknowing consumer, it can be frustrating to buy a microwave, a 2.4GHz cordless phone, a 2.45GHz video transfer system, and a 2.4GHz WLAN, and then find that only some work error-free once installed in the home.

Manufacturers often take the view that as long as their products are certified, interference it the other guy's problem. What most manufacturers fail to acknowledge is that the consumer ultimately ends up with the problem. Unfortunately, consumers don't necessarily know why it doesn't work, just that it doesn't. These devices often end up as returns or consumer complaints.

(*Extracted from: "*Residential Spectrum Management: The Manufacturer's Role*", David A Case, Compliance Engineering 2005 Annual Reference Guide, pages 106-107, www.ce-mag.com.)*

444) Interference with household appliances from living too close to a transmitter

Residents living near the ABC's main radio transmitter at Liverpool have complained repeatedly of interference from the powerful signals it emits, amid concerns that planners have overlooked the impact of electromagnetic radiation on the area. Residents in a new housing estate at Prestons, which is across the road from the tower, have had the signal from the ABC radio station 702 interrupting phone calls, throwing lines across television screens and turning electronic equipment on and off without warning.

"There would be music at the back of our phone calls," one resident, Arvin Prasad, said.

"Telstra kept saying it was not their problem but finally they fixed it. They put some kind of filter on the lines."

Another resident, Marina Baldin, said: "I had one of those touch lamps. It used to go off and one by itself. I got rid of it."

The Herald reported last week that the five AM radio transmitters at Homebush Bay will have to be moved because Planning NSW has given approval for a multistorey building 200 metres from the 2UE-2SM transmitter. No one is yet living at Homebush Bay, and the issue is who will pay the $40 million cost of moving the transmitters.

But at Prestons people have been living for more than a year in two-storey houses within 350 metres of the ABC tower. The ABC broadcasts at 50 kilowatts - ten times the power of the AM stations at Homebush. The packaging company Amcor, which is investigating a new plant on the old Liverpool showground site 400 metres away, commissioned a study which yielded alarming results.

Readings at ground level were well below safe levels for non-ionising electromagnetic radiation, but at five metres were above the safe limit. The company has been advised it would need to shield equipment in the factory to avoid malfunctions.

The ABC's director of technology, Colin Knowles, disputed the Amcor findings yesterday, saying the ABC's own testing at Prestons showed radiation levels were well below those permitted under Australian standards. "This is the same problem that airports experience. People complain about airport noise, but they build out near the airport," he said.

The ABC tower has been at Liverpool for 67 years. One resident who complained to the ABC was told to direct his concerns to Liverpool Council, which gave permission for the new housing development. A council spokesman was not available yesterday.

(*Extracted from: "*Neighbours find ABC has turned the radio up too far*", Anne Davies, Urban Affairs Editor, Sydney Morning Herald, 24 February 2003. Also see: "*Planning debacle forces radio towers to seek new home*", 17 February 2003, http://www.smh.com.au/articles/2003/02/16/1045330466812.html, and "*Government admits radio towers, units were too close*", 18 February 2003, http://www.smh.com.au/articles/2003/02/17/1045330538774.html, also by Anne Davies in the Sydney Morning Herald.)*

445) Electronic Articles Surveillance (EAS) systems interfere with disabled aid

My work includes the installation of induction loops for hearing aid users. The availability of these is almost the only way of complying with the Disability Discrimination Act in public buildings which have an amplification system.. Many hearing aid users will not, for example, attend a Church which does not have a working loop system. These generate an audio magnetic field which is received by a special pick-up coil in the hearing aid.

One of the more widespread sources of interference to induction loops is the security system used in larger shops and libraries. The library building in Halesowen has a small theatre on the top floor. Tests reveal a 1kHz audio signal throughout the whole building including the whole of the theatre. The source of this is the security system to stop theft of books. These consist of a pair of coils which form a "gateway" through which all books have to be carried.

The flagship library in Bournemouth town centre has this security system. The necessary induction loops fitted to the desks where the Library Staff issue books for borrowing have to be at least 5 metres away from these. Otherwise the background whistle is intolerable. On one visit there, I happened to have an induction loop monitor with me. Out of curiosity, I tried the desk loop and found that the background whistle was intrusive even at the furthest point on the counter.

On another occasion, I happened to need a new bulb for my car, and visited one of Birmingham's car parts shops on my way home from a service job. Seeing a similar security coil system in the shop, I went back in with a loop monitor and found that the whistle was audible out in the car park as well as at the cash desks where shops are now having loops fitted.

Getting cynical in my old age, I think that the audio spectrum falls off the bottom end of the 9kHz or 150kHz lower limit of a lot of EMC specifications, and so does not enter people's thinking. On the other hand, specifications that limit noise emissions into mains supplies seem irrelevant when someone is designing an audio magnetic radiator such as is used in these security gateways.

(*Sent in by Robert Higginson of AREAC, 2nd August 2007)*

446) Some more examples of medical interference

- A video system used for endoscopy experienced random episodes of interference during electrocautery.
- Cardiopulmonary bypass blood pumps stopped unexpectedly during surgery.
- An infusion pump changed rate when a cellular phone was placed on the instrument stand.
- A fetal hearth monitor located in a nursery experienced incorrect readings. A wireless base station had been placed on a wall outside the nursery.

*(Taken from the PowerPoint presentation of: "*Medical Equipment Immunity Assessment by Time Domain Analysis*", Mireya Fernández-Chimeno, Miguel Ángel García-González and Ferran Silva, 2007 IEEE International Symposium on Electromagnetic Compatibility, 8-13 July 2007, Honolulu, Hawaii, ISBN: 1-4244-1350-8, IEEE EMC Society: http://www.ewh.ieee.org/soc/emcs. These examples were previously reported by Silberberg J.L, in: "*What Can/Should We learn from Reports of Medical Device

Electromagnetic Interference?*", Proceedings on Electromagnetics, Health Care & Health, Paper 10.2.1.3, Montreal, Quebec, Canada. 1995.)*

447) Fibre-optics used in 'EMI-Immune' Aircraft Program

Maryland-based Optelecom-NKF, Inc. has announced that its Electro-Optics Systems Group has received a contract from Parker Aerospace for optical fiber control system architecture design in support of the Electromagnetic Interference (EMI) immune aircraft program, designated AVE3I. The Parker Aerospace contract is part of an Air Force Research Laboratories (AFLR) program to develop EMI-immune aircraft. Parker Aerospace is under contract to GE Aviation, the prime contractor in the Air Force contract. The AVE3I program is scheduled to advance in several stages through design, laboratory demonstration, and, potentially, flight demonstration.

According to Bill Ziegler, the Electro-Optics Group's Program Manager, "This contract continues our long-standing emphasis on developing optical fiber-based systems to protect aircraft from the threats associated with EMI."

(*Extracted from "*Optelecom-NKF Wins Contract in Support of EMI-Immune Aircraft Program*", EMC News, Interference Technology's Online Guide to EMC, August 5th 2007, www.interferencetechnology.com/emcnews/id1308.)*

448) EMP could threaten existence of civil society in the US

Over the past seven years, a substantial number of articles have been written by this author and others identifying the threat and importance of intentional electromagnetic interference (IEMI). The major conference for this topical area was the AMEREM Conference in July 2006 in Albuquerque, New Mexico. This is the major conference in the world dealing directly with high power electromagnetic environments, effects, and protection, including IEMI and all types of nuclear EMP.

A second area to be discussed in this article is the work of the Congressional EMP Commission in the United States. As part of their study, they examined the historical record of information including data from high-altitude nuclear tests performed by the United States and the Soviet Union in 1962, and they directed research to evaluate the susceptibility of today's critical architecture. They completed their work in 2004 by describing the HEMP threat to the U.S. infrastructure, and they took up their work again in May 2006 to review the response to their initial report and to encourage those responsible for the critical infrastructure to develop mitigation methods to deal with the threat.

The terminology of the electromagnetic pulse has evolved over the years, but today the generic term for all types of nuclear generated electromagnetic transients is EMP. Of interest here is the EMP caused by a high-altitude burst, generally defined as one occurring at a burst height greater than 30km. At this altitude, the radiation produced by the nuclear burst would not reach the earth's surface, but several types of electromagnetic signals would. Because the burst is at high altitude (in space), this type of EMP is usually referred to as HEMP. The concern is that these high-level electromagnetic fields will create serious problems for computers and other electronic systems on the earth's surface, including the critical infrastructure (power, telecommunications, transportation, finance, water, food, etc.). This is the focus of the EMP Commission in the United States and the IEC subcommittee 77C in Geneva.

While the EMP Commission studied all major aspects of the critical infrastructure, they determined that the power system was the most critical because of its connection to all of the other major infrastructures such as communications, transportation, emergency services, energy distribution, water/food, etc. After considerable study, the commission concluded:

1) HEMP-induced functional collapse of the electrical power grid risks the continuing existence of U.S. civil society.

2) Early-time HEMP transients are likely to exceed the capabilities of protective safety relays.

3) Late-time HEMP could induce currents that create significant damage throughout the grid.

4) The national electrical grid is not designed to withstand near simultaneous functional collapse

5) Procedures do not exist to perform "black start" after and EMP attack as restart would depend on telecom and energy transport, which depend on power.

6) Restoration of the national power grid could take months to years.

7) HEMP-induced destruction of power grid components could substantially delay recovery.

The HEMP threat is one of a few potentially catastrophic threats to the United States.

(*Extracted from: "*2007 Update on intentional electromagnetic interference (IEMI) and high-altitude electromagnetic pulse (HEMP)*", by Dr William A Radasky, Ph.D., P.E., Interference Technology's EMC Directory & Design Guide 2007, pages 143-148, www.interferencetechnology.com. A* very similar article: "*High-Altitude Electromagnetic Pulse (HEMP): A Threat to Our Way of Life*", with more technical detail and the same list of risks as regards the US power grid, is available from: http://www.todaysengineer.org/2007/Sep/HEMP.asp. For the Congressional Report itself, visit: http://www.globalsecurity.org/wmd/library/congress/2004_r/04-07-22emp.pdf, http://www.empcommission.org/docs/A2473-EMP_Commission-7MB.pdf, and http://www.fas.org/sgp/crs/natsec/RL32544.pdf)

449) Explosive material probe and implantable medical devices

An 'In Vitro' study was made of the electromagnetic interactions between a hand-held probe used for detecting explosive materials, and implantable medical devices such as pacemakers. The probe uses a quadrapole nuclear resonance technique, and was tested with fifteen devices from three major manufacturers. Testing has been completed and a number of interactions were found. The severity of the interactions has yet to be determined.

(*Adapted from "*Wireless EMC in the Medical Industry*" by Hank Grant et al., speaking in the "Current EMC issues in healthcare" workshop session of the IEEE 2002 International EMC Symposium, Minneapolis, August 19-23 2002.)*

450) Wireless phone and medical devices

- Specific recommendations for cellular telephones:
  Designate locations where they can be used without concern of interference;
  Prohibit patients and visitors from using cell phones and similar devices within highly-instrumented clinical areas;
  Consider whether or not cellphones and similar devices should be permitted in general patient care areas;
  Consider allowing wider use of cell phones and similar devices by clinical staff;
  Instruct staff to maintain a minimum distance of I meter (3 ft) – but preferably greater;
  Consider cordless phone use.
- Specific recommendations for walkie-talkie and FRS (family radio service) devices:
  Prohibit use by patients and visitors;
  Allow use by necessary staff:
  Do not allow use in 'talk' mode within 6 to 8 meters (20 to 25 ft) of highly instrumented areas; Ensure that staff are aware that walkie-talkie transmissions can penetrate walls, floors, and ceilings, which may affect medical devices in adjacent rooms or floors.

*(Adapted from "*ECRI's Updated EMC-Healthcare Recommendations & Utility of Ad-Hoc Testing*" by Art Augustine, speaking in the "Current EMC Issues in Healthcare" workshop session of the IEEE 2002 International EMC Symposium, Minneapolis, August 19-23 2002.)*

451) Value of Ad-Hoc EMC testing in hospitals

Ad-Hoc testing is important in healthcare because many older medical devices that are still in use in hospitals were not designed or tested for EMC and even newer medical devices that meet EMC standards can experience electromagnetic interference in use. For example:

- Wireless PDA interfered with 42% of tested critical care medical devices (Juett, S. "Healthcare EMI war stories / due diligence", AAMI 2001 Conference and Expo, June 2001, www.aami.org.)
- Critical function of four of 33 medical devices disrupted by cell phone at 25cm or greater (Morrisey et al., "Characterisation of electromagnetic interference of medical devices in hospital due to cell phones"", Health Physics, vol. 82, no. 1, pp. 45-51, Jan 2002.)
- RF wireless LAN interfered with three of 44 medical devices tested (Rice, W.P. "2.4 GHz RF WLAN EMI in medical devices", J. Clkin. Eng., vol 25, no. 5, pp 260-264, Sep/Oct 2000.)

*(Adapted from "*Status of the Second Edition of the ANSI C.63.18 *Ad-Hoc* Test Method*" by Jeffrey L Silberberg, speaking in the "Current EMC Issues in Healthcare" workshop session of the IEEE 2002 International EMC Symposium, Minneapolis, August 19-23 2002.)*

452) More on mobile phones and medical devices

Since the beginning of the nineties there have been warnings not to sue mobile phones in the vicinity of medical devices. Functional failures of dialysis machines, respirators and defibrillators prompted the banning of their use (mobile phones – Editor) in many hospitals in Scandinavia, and then in other countries. Since we believe that a general ban in hospitals is problematic, we decided to investigate the influence of mobile telephone on life-saving and/or life-support systems, with the aim of establishing rules for its use in hospitals.

A total of 224 devices classified into 23 types of devices were examined. Nine different sets of transmission conditions were applied, giving a total of 2016 tests.

We would therefore recommend that all life-saving and life-support systems that can be used outside the hospital should be made mobile phone proof (this implies testing at the relevant frequencies, with the relevant modulations, at polarisations and levels – probably at 50V/m at least – Editor). When apnoea monitors and respirators are protected from such interference, hazardous situations could be avoided by establishing the rule: "No portables, and mobile phones only at a distance of at least 1 metre from medical devices". With regard to emergency telephones, the minimum distance to medical devices should be at least 1.5 metres.

(Taken from a translated abstract of "Effect of mobile phone on life-saving and life-sustaining systems", Irnich W, Tobisch R, Biomed. Techn. (Berl) 43(6):164-173, 1998.)

453) Evidence of the dangers of mobile phone use in hospitals

- Electrocardiogram traces--interference caused baseline noise (generally not severe enough to be clinically relevant) [5]
- Electrocardiogram traces--interference caused baseline noise (generally not severe enough to be clinically relevant) [5]
- Defibrillators--affected by screen judder; with more powerful phones the units switched off, changed input selection, dumped their stored energy, and displayed asystole incorrectly [4]
- Anaesthetics machines--displayed incorrect oxygen values when mobile phones were used 1 m or less away [4]
- External pacemakers--incorrectly sensed pulses and consequently failed to deliver paced output [4]
- Infusion pumps--prone to alarms and error messages and even reversal in pump direction when phones were less than 1 m away [4]
- Medical monitors--61% had changes to readings, severe judder, buzzing, and system crash when phones were further than 1m away [4]
- Dialysis machines--at 0 m, readings were distorted by phones [4]
- The maximum distance at which any phone caused interference was 2 m; phones closer than 88 cm caused the most severe interference [5]

[4] Medical Devices Agency. Electromagnetic compatibility of medical devices with mobile communications. London: Medical Devices Agency, 1997. (MDA DB 9702.)

[5] Ri JL, Hayes DL, Smith TT, Severson RP. Cellular phone interference with external cardiopulmonary monitoring devices. Mayo Clin Proc 2001;76:11-5.

(*Extracted from: "*Using mobile phones in hospitals: what's the worst that could happen?*", by Layla McCay and Andy Smith, studentBMJ 2003;11:43-86 March ISSN 0966-6494, http://student.bmj.com/issues/03/03/education/52.php)*

454) Video projector interferes with audio induction loop

Installers of various equipments may not be aware of audio magnetic induction loops, which are an aid for the disabled. These produce magnetic fields across the whole audio range but primarily from 100Hz to 5kHz with a nominal field strength of 100mA/m in the listening area. Achieving this may mean fields of at least 10A/m a few centimetres from the loop cable.

BS7594, Guidelines for Induction Loops, includes advice to minimise susceptibility to magnetic interference. Basically, these give ways of avoiding a large area earth loop.

A Church where we had installed an induction loop bought, a few years later, a new video projector and computer system. We were called because the installer of the projector was complaining that our loop did not meet specifications, and was causing interference. The picture had "hum bars" moving up and down the screen.

I cured this with nothing more than a 5 metre mains lead. I plugged the projector into the same mains socket as the computer, thus minimising the earth loop. As a further test, I measured loop current and magnetic field, and could show that the installation was close to a text-book example of the theory in BS7594. The video projector supplier had plugged this into a mains supply installed for other equipment.

This was a text-book example of the earth loop which BS7594 warns against. During this dispute, the video supplier had arranged a demonstration of an induction loop which he hoped the Church would purchase. Hearing aid users were not impressed with the loop quality compared with the existing installation. Installing the loop cable on the steel reinforced concrete floor reduced the interference to the video projector. But it also reduced the useful signal to hearing aids, and was not acceptable.

(Sent in by Robert Higginson of AREAC, 2nd August 2007)

455) Switch-mode power supply emissions vary strongly with mains voltage

It's very tempting to believe the CE mark and Declaration of Conformity of a bought-in power supply, but… A power supply with active mitigation (PFC) was tested at 220V and behaved perfectly reasonably. But at the UK version of the harmonized European 230 V, actually 244 V, it drew current from only one half-cycle of the mains supply, and emitted very significant amounts of even harmonic currents and DC. This behaviour persisted down to 227 V, then the current in the 'other' half cycle gradually increased, so that at 222V the waveform was reasonably symmetrical and the second harmonic emission was very low.

This has been reported anecdotally before, but the effect is not widely known. It can be even more marked if the output current is well below the rated value. Half-wave operation is, of course, a big 'No-No' according to the standard, except under very special circumstances.

Ideally, all users of OEM power supplies should check the emissions with a power analyser, which can be much less costly than the full-specification IEC/EN 61000-4-7 instrument and gives reasonable results on fluctuating loads. But at least an observation of the input current waveform, using a current probe or low-value resistor and an isolating transformer, will detect half-waving and other misdemeanours, such as cycle-skipping, that may affect the equipment being powered, or even other associated equipment.

(*Copied entire from: "*John Woodgate's Column*", by John Woodgate, The EMC Journal, January 2007, pp 13-14, www.compliance-club.com.)*

456) EM emissions from hybrid vehicles

The results from the emission testing carried out on the seven alternative powertrain vehicles have, with one exception, been found to exceed the emissions limits as specified by 95/54/EC, CIPSR 12 and 97/24/EC. The majority of the excessive emissions correspond to vertical polarisation for broadband, and the maximum frequencies for these excessive emissions were 127MHz for broadband and 144MHz for narrowband.

Since the vehicles were tested under dynamic conditions where practicable, the vehicles may well have met the requirements of 95/54/EC when tested in the normal 'static' mode, whilst producing emissions in excess of the legislative limits when the power electronics and electrical machines are activated.

Nonetheless, the results from one of the hybrid electric vehicles demonstrate that a well-engineered hybrid electric vehicle need not present any more of a threat than conventional IC (Internal combustion) engined vehicles.

(*Extracted from "*Investigation of electromagnetic emissions from alternative powertrain road vehicles*", Alastair Ruddle, Executive Summary, MIRA report No: 01-845060, 28 May 2002, www.mira.co.uk.)*

457) Computer interferes with amateur radio

One investigation revealed a computer that was putting out a strong fifteenth harmonic on the two-meter amateur bands (144-148MHz). It was energetic enough that a mobile operator could not access a repeater 15 miles away. Rearranging the cables and some shielding solved the problem.

(*Taken from "*Energy leakage from LANs*", Chester L Smith, ITEM 1997, page 160, www.interferencetechnology.com.)*

458) ESD in Fluid lines

From 1953 to 1971 over 35 accidents involving fire and explosions in aircraft during or after fuelling were attributed to electrostatic discharge (ESD). Most of these accidents involved JP-4 hydrocarbon fuel flowing through nonconductive fuel lines with TEFLON® as the hose liner. These fluid lines consisted of an extruded Teflon tube reinforced with a braided stainless steel outer jacket. Many of the ESD failures produced leaks in the hose. Fluid line leaks were also observed during the testing of the Pratt & Whitney J57P55, the Westinghouse J34WE46 and the General Electric CJ805 engines.

One failure that occurred in the aerospace industry during the late 1960's on a spacecraft launch vehicle had an interesting effect on the spacecraft. The guidance computer commanded the propulsion to shut down early, preventing the vehicle from reaching its design altitude. After extensive review of the telemetry and the systems design, it was concluded that ESD had caused the guidance computer to malfunction. The source of the ESD was researched extensively and found to be the nonconducting Freon lines which ran internal to the computer. The ESD arced through the Teflon and into the computer causing the malfunction to occur.

Laboratory experiments on this configuration were performed to verify that ESD could occur. It was discovered that it took around 20,000 volts to arc through this Teflon thickness. Also, it was found that the resistivity of the coolant did not follow Ohm's law. The liquid resistivity showed an increase when the electric field was increased. This phenomenon was also observed for hydrocarbons by Kinkenberg and Van der Minne.

A more recent event occurred in January 1996 with the integration and testing of the Spacelab Multi-Purpose Experiment Support Structure (SL MPESS) carrier for the United States Microgravity Payload-3 (USMP-3) on the ST-75 shuttle mission. During the Freon flow balancing of the USMP-3 Freon system, a leak was discovered in one of the Freon flex lines. ESD was suspected and later confirmed by the Kennedy Space Center (KSC) material science division and this author.

During investigation of the Spacelab fluid line failure, another ESD failure was found on a space shuttle ground support equipment fluid line. The fluid line carried N2O4 at the fuel storage facility. The KSC materials laboratory recommended conducting fluid lines in this application.

It is hoped that this article will encourage greater awareness and that special care will be taken in the design and routing of fluid line systems in the future.

(*Extracted from: "*ESD in Fluid Lines: Theory and Application in the Petroleum and Aerospace Industries*", Robert A Green and Robert S Axley, ITEM 1997, pp 108-139, www.interferencetechnology.com.)*

459) Hi-tech ambulance gear goes to waste

Millions of dollars worth of communications equipment installed in ambulances nationwide has been sitting idle for six months because it interferes with radio reception.

New Zealand's 550 ambulances were fitted with mobile data terminals and automatic vehicle locators worth $3 million in November and December as part of a $16 million call-centre upgrade, which saw eight communications centres merged into three.

"Six months on, we just have these useless things sitting on the dashboards and it feels like we're operating blind half the time," said an ambulance officer who did not wish to be named. Staff were told that the units - which were meant to relay patient information - would be in place before the merger early this year, but that had not happened, the officer said.

Since the closure of communication centres in New Plymouth, Hamilton, Palmerston North and Masterton in February, all ambulance calls have been routed through Wellington, Auckland and Christchurch.

At the time of the closures, St John communication centre coordinator Tony Blaber said local knowledge on the ground would not be lost thanks to the cutting-edge technology, which would allow dispatchers to pinpoint the location of calls and direct the nearest ambulance or rescue helicopter to incidents.

Mr Blaber told The Dominion Post that during trials the screens, which accounted for $500,000 worth of the project, had been found to interfere with the quality of radio reception at the "extremities" of the signal. "For most places in the country where the radio signal is strong, there would be no problem, but for isolated pockets where it's marginal, it had a slightly degrading effect."

Trials were under way around New Zealand and upgraded screens should be in place by the end of July. Though it was disappointing that the system was not completely operational as yet, the new centres had been doing an excellent job, he said.

(*Copied entire from "*Hi-tech ambulance gear goes to waste*", by Ruth Hill, The Dominion Post, Monday, 11 June 2007, http://www.stuff.co.nz/4090561a11.html?source=email. An anonymous person told us: "The problem was all due to a crappy LCD display that was made in China and was CE marked!")*

460) Atlantis Undocks; Computer Glitches Overcome

As the eNews is being prepared, the shuttle Atlantis has undocked from the International Space Station (ISS) and is preparing to land at Cape Canaveral on Thursday morning if weather conditions permit. During this eventful mission (Expedition 15), the crew completed construction work and repairs and endured a computer meltdown. Although Russian sources quoted last week had blamed electromagnetic interference from a new U.S. solar array for the failure of the Russian computers, the latest postings on NASA's website contradict this assertion. According to troubleshooting reports posted on the NASA website. "...the crew used a current scopemeter (oscilloscope) in the Node endcone to check on the quality of current on three wire harnesses that feed current to the RS (Russian segment), in order to determine if EMI (electromagnetic interference) was traveling down one of the lines as noise which could upset a noise-sensitive power supply cord. Results were evaluated on the ground, and the power was found clean of any noise.

Root cause analysis is underway, and one suspicion is that a change in the ground state—i.e., a difference between the vehicle's electrical potential and the surrounding plasma vacuum, caused sensitive protective secondary power circuitry to turn off the primary power supply on sensing an 'overvoltage." The computers that are key to maintaining necessary thrust are now operational, and the first steps to re-entry have been taken. For a detailed account of the troubleshooting process, go to the NASA website http://www.nasaspaceflight.com/content/?cid=5138.

Quote from the NASA site: 'Results were evaluated on the ground, and the S4 power was found clean of any noise and was exonerated,' it was noted, clearing the truss from the fault tree. However, the installation of the new addition to the station may ultimately have started the chain of events with the Russian computers.

'Root cause analysis is underway. One speculation under consideration is that changes in the ground state, i.e. the difference between the vehicle's electrical potential and the surrounding plasma 'vacuum', caused sensitive protective secondary power circuitry to turn off the primary power supply on sensing an overvoltage,' added NASA information. The jumpers bypass either the sensitive logic or the entire overvoltage protection.'

'A grounding change could have been caused by the addition of the 36,000-lbs S3/S4 truss and a change in the plasma environment or a change in ground path caused by the rewiring and circuit changes. More analyses are required to confirm or change this hypothesis. The ISS is the largest structure ever erected in space, and this situation cannot be tested on the ground. But the experience will help teach us how to build the large space structures of the future.'

(*Copied from: "*Atlantis Undocks; Computer Glitches Overcome*", Interference Technology online newsletter, eNews, 21 Jun 2007, www.interferencetechnology.com.)*

461) Magnetic fields at railway stations

During the last five years there have been many articles, letters and comments in journals and magazines about the effects of electromagnetic interference. The range of items supposedly affected, from materials and object to people, has been enlightening and often salutary in revealing that electricity apparently has more side effects than most drugs. Items varying from reasoned argument to outright hysteria have made interesting reading. I wonder what the final judgement on the discovery of electricity will be.

As a telecommunications engineer, my work takes me to places spread over a large part of the UK. Several years of self-employment and the resulting accounts have led me to abandon my own road transport in favour of rail, bus, taxi, air and the occasional hire car. Thus, I get to stand on railway stations and observe the world for a while.

Guildford is one of these locations and EMI (electromagnetic interference) can visibly be found there. The station was rebuilt while I was using it, and the reconstructed platforms have nice new colour-TC monitors installed for announcements. Do not read them. Just watch, particularly when a train starts up or is due to arrive at your platform – the colour changes can be amazing.

I have yet to take a magnetometer with me and measure the field strength, but the magnetic field set up by the circulating current in the track is enough to destroy the colour scanning of monitors in use 40 ft from the track. The effect only exists if the current path passes a platform, though since the substation supplying Guildford is north of the station and the supply section runs for several miles south of the station, this can be a while. The arrival of a northbound train can be determined from the effect, minutes before any station announcements.

(*Taken from a letter entitled* 'Train of Thought*' by A.N. Morris, dated 15th October 1990, in IEE News 1990/No 51, page 3, www.theiet.com.)*

462) Airbus Receives Okay for In-Flight Mobile Phone System

European aircraft manufacturer Airbus has received an "air-worthiness" certification for a cell phone system on an aircraft. Earlier this month, the European Aviation Safety Agency (EASA) approved Airbus' GSM (global system for mobile communications) on-board system. The ESA air-worthiness certification comes after successful tests had been carried out by Airbus earlier this year that confirmed the GSM system's compatibility in an aircraft environment.

With this approval Airbus has taken a major step toward airline operation of the OnAir service that will enable passengers to use their Blackberry®-type devices and mobile phones during flights in Europe. Passengers will be able to make and receive calls and to receive emails and text messages. The cabin crew can easily manage the service and have the option of selecting "voice-off" mode, which allows only SMS text messaging and emails. In air use of cell phones is still not permitted on U.S. flights, amid long-standing controversy about possible interference with aircraft controls. For more details, see the press release on the Airbus website: http://www.airbus.com/en/presscentre/pressreleases/pressreleases_items/07_06_19_onboard_mobile_certif.html.

*(Copied entire from "*Airbus Receives Okay for In-Flight Mobile Phone System*", EMCnews, in Interference Technology's on-line newsletter, 28 June 2007, www.interferencetechnology.com, http://www.interferencetechnology.com/emcnews/id1287)*

463) EMC is of critical importance to US Navy

In 1986, the US Navy reported that EMC/EMI was of critical importance to the Fleet. This was as a result of them having suffered many problems in recent years. It led directly to the creation of NARTE, to satisfy the U.S. Navy's requirements for engineers with EMC training.

(*Taken from a presentation about the National Association of Radio & Telecommunications Engineers, Inc. (NARTE, Inc., www.narte.org) at the EMC Test Laboratories Association (EMCTLA, www.emctla.co.uk) meeting at Wrag Barn, Swindon, 16th July 2007.)*

464) AC sags interfere with appliances

We recently had a short and modest line-voltage sag at home, no big deal. While the incandescent lights dimmed slightly and came back up, nearly everything else was, as logic designers so elegantly say, "indeterminate." The PC chattered internally and went wild; some of the compact fluorescents lamps (CFL) came back on, but some did not; the displays on the oven and microwave became random segments; and the home network crashed but eventually reinitialized itself.

It was the plain 900-MHz cordless phone, a relatively simple device, which really showed the most bipolar behavior. The base station indicator LED said the phone was cradled and charging even though the phone was absent; the phone itself would not connect and provide dial tone. The solution was the usual tactic: unplug and restart. I unplugged the base unit from its wall wart; that cleared both the base station LED and its operating cycle. I still had to open the phone to disconnect/reconnect its battery, to reclaim that dial tone, though.

I know "stuff happens", but this particular stuff indicates both how dependent we are on decent line power, and how poorly designed many lower-cost products are for even slight dips in the mains. There are plenty of good voltage-monitor ICs available for line AC as well as low-voltage DC, but they cost money and board space. So end-users, your average customers, have to be prepared to go around and manually reset lots of their appliances.

To add to the frustration, many of these devices have soft, not hard, power on/off switch functions (see "When an on/off switch really does that"), so the user has to unplug the AC cord. That's not a big deal, unless you have to start moving some big furniture to get to the outlet. Would a whole-house line conditioner be a better idea?

(*Copied entire from: "*AC sags cause appliance confusion*", Bill Schweber, Planet Analog, Jul 30, 2007 (8:25 AM), http://www.planetanalog.com/showArticle.jhtml?articleID=201201716)*

465) Lorry's crane interferes with central locking

One time, neither of the keyfobs for my Renault car worked. It took me a while to make the connection between the operation of a crane on a nearby lorry that was unloading stone, and my keyfob malfunctions. The lorry's crane was radio-controlled by a hand-held unit. As soon as the guy stopped operating the crane, my key fobs worked properly again.

(*Submitted by Frank Jetschmann of Endress & Hauser, August 2nd 2007.)*

466) Interference from Navy locks Seattle auto dealer out of all of his cars

An automobile dealer in Seattle couldn't get into any of his cars, due to military radars on nearby U.S. Navy ships.

(S*ubmitted by Bill Radasky of Metatech Corp., 2nd August 2007)*

467) Wi-Fi interferes with collision avoidance system in B737-800, ASRS Report: 673795

Synopsis: B737-800 flight crew experienced several TCAS RA's allegedly generated by a Wi-Fi enabled laptop computer. TCAS = Traffic Alert and Collision Avoidance System.

20th Sept 2005, 1201 to 1800, Aircraft type: B737-800, Operating Under FAR Part: Part 121, Flight Phase.Climbout: Initial, Flight Phase.Climbout: Takeoff, Independent Detector. Aircraft Equipment: TCAS. FLT XXX, A B737-800 ZZZ-ZZZ1.

After take off near maximum gross weight, prior to flap retraction, received a resolution advisory (RA) 'MAINTAIN VERT SPD' with red area not to decrease to 1500 FPM or less rate of climb. Delayed thrust reduction and flap retraction to comply with RA and scanned for TFC. TCAS indicated a co-altitude target (red circle) less than .01 behind us. This occurred at 1000 FT MSL, and cleared up approx. 30 seconds later.

Second RA occurred near 12000 FT MSL. Same target indication, a red circle co-altitude less than .01 behind us. Now the RA advised 'DSND, DSND, DSND.' We started the descent, advising ATC of the RA and scanning for TFC. ATC advised us there was nothing in out vicinity, and TCAS was clean of targets for nearly 10 miles. Began to suspect EMI from cabin.

Started to climb again – ignoring the TCAS RA commands. The box was quiet. Recycled the transponder power at 14000 FT, we got a third TCAS RA. Same display and callouts. We ignored them and called cabin for a check of equipment that may have caused interference.

Found passenger seated in First Class with laptop Model HP 6220 with wireless function enabled. The passenger closed the lid when we were boarding, putting the laptop into standby/hibernate mode. Once he disabled the wireless function, all OK.

The technical people should get a heads-up on this. Guess the wireless function was trying to establish a connection and each time it did (or a fraction of the attempts) was interpreted as a TCAS signal. (co-altitude, .01 behind us.) The display was a red circle, not a red square. No yellow or white circles prior to any RA events. Is the TCAS antenna cable shielded from internal (cabin computers) EMI?

I have not seen an event like this before. What makes it hazardous – is the rate of climb at departure, prior to acceleration and flap retraction and the 1500 FPM or greater rate of climb (TRANSCON near maximum take-off weight.) With the proliferation of wireless-enabled computers, I am sure we will be seeing this more often.

(The above report is extracted from ASRS Report: 673795, taken from the Aviation Safety Reporting System (ASRS) run by NASA, to which pilots and other aircrew can voluntarily report incidents. On January 23rd 2007 they released a report of 50 incidents taken from the ASRS that involve the use of Passenger Electronic Devices (PEDs). Not all of the reported incidents concern electromagnetic interference (EMI). This report is very useful when you need to show people that some PEDs can interfere with some aircraft systems and communications. You can download it from: http://asrs.arc.nasa.gov/report_sets/ped.pdf. Also see Banana Skins Numbers 186 – 189, for an earlier ASRS report.)

(http://en.wikipedia.org/wiki/Traffic_Collision_Avoidance_System says (on 10th August 2007): The Traffic alert and Collision Avoidance System (or TCAS) is a computerised avionics device which is designed to reduce the danger of mid-air collisions between aircraft. It monitors the airspace around an aircraft, independent of air traffic control, and warns pilots of the presence of other aircraft which may present a threat of mid-air collision (MAC). It is an implementation of the Airborne Collision Avoidance System mandated by International Civil Aviation Organization to be fitted to all aircraft over 5700 kg or authorised to carry more than 19 passengers.)

468) Interference with aircraft VHF voice communications. ASRS Report No. 661013

Synopsis: Flight crew of CRJ-700 reports that aural interference in VHF communications ceased when passengers were asked to ensure all forms of 2-way communications were turned off.

On climbout from CLT we heard what sounded similar to a fax machine sound or modem sound. We thought it was just an anomaly, but it happened again and again in repetitious intervals. I asked the Captain what he thought, and he said it was probably a 2-way pager because a similka5r incident occurred to him a few trips ago. He found that out after asking a flight attendant to investigate the situation, and she found someone was typing messages above 10000 FT MSL so that they could be sent upon landing.

We asked our flight attendants to take a walk through the cabin to see if anyone was using anything of the sort. None were found after she reported back to us. However, the annoying noises still continued. It was annoying and loud enough to almost cause us to miss radio calls. So, an announcement was made to please make sure cell phones and 2-way pagers were turned off because it was upsetting our communications, and if this was not done we may have to return to CLT.

After that, nearly the entire plane got up to find and make sure all devices were turned off. The noises then stopped. No model information was gathered because: the flight attendants were doing their SVC; we were still climbing; and we assumed no one was going to admit guilt for fear of prosecuting action.

Recommendation: I would highly encourage many more in-depth studies to be performed prior to allowing cell phones and other communications devices to be used on board aircraft in flight.

(The above report is extracted from the 23rd January 2007 ASRS Report, No. 661013, http://asrs.arc.nasa.gov/report_sets/ped.pdf. See Banana Skin number 467 for more information on NASA's ASRS reports.)

469) Jammed motor interferes with cell phone base station

I was called out to try to solve a problem with a cell phone base station that did not work. Its dedicated UHF communication channel to the rest of its cellphone network was being jammed by external interference. The problem turned out to be a stepper motor driver in an air-conditioning system in the building the base station was located on.

The stepper motor was controlling a flap in the air-conditioning system, so the motor was only required to operate for a few seconds, every now and again. The stepper motor's driver circuit emitted significant amounts of radiated noise at exactly the frequency of the base stations network communication channel.

In normal use, the base station comm's would only be blocked for a few seconds, every now and again, and this level of interference would hardly have been noticed. But the flap had become jammed due to a mechanical fault, so the motor was on continuously, trying to move it to the desired position, and so the base station comm's channel was being continuously jammed.

The culprit stepper motor driver, with its high levels of emissions, is almost certainly installed in the air conditioning systems of many thousands of buildings.

(*Sent in by Les Dickenson, Manager of the Sydney Laboratories of EMC Technologies Pty Ltd, Australia, www.emctech.com.au, on the 1st June 2007.)*

470) A Practical Procedure to Prevent EMI with Medical Equipment

Problems involving electromagnetic interference (EMI) with electronic medical equipment are well-documented. However, no systematic investigation of EMI has been done. We have systematically investigated the causes of EMI. The factors involved in EMI were determined as follows:

1) Electric-field intensity induced by invasive radio waves from outside a hospital.

2) Residual magnetic-flux density at welding points in a building.

3) Electric-field intensity induced by conveyance systems with a linear motor.

4) The shielding capacity of hospital walls.

5) The shielding capacity of commercial shields against a wide range frequency radio waves.

6) The immunity of electronic medical equipment.

7) EMI by cellular telephone and personal handy-phone system handsets.

From the results of our investigation, we developed a following practical procedure to prevent EMI:

1) Measurement of electric-field intensity induced by invasive radio waves from outside the hospital and industrial systems in the hospital.

2) Measurement of residual magnetic-flux density at electric welding points of hospital buildings with steel frame structures.

3) Control of the electromagnetic environment by utilizing the shielding capacity of walls.

4) Measurement of the immunity of electronic medical equipment.

5) Installation of electronic gate equipment at the building entrance to screen for handsets.

(*Abstract for: "*A Practical Procedure to Prevent Electromagnetic Interference with Electronic Medical Equipment*", Eisuke Hanada et al., Journal of Medical Systems, Springer Netherlands, ISSN 0148-5598 (Print), 1573-689X (Online), Volume 26, Number 1 / February, 2002, DOI 10.1023/A:1013094904976, Pages 61-65.)*

471) iPods can interfere with pacemakers

A study presented at a recent medical conference in Denver has concluded that electromagnetic interference from an Apple iPod digital music player has the potential to adversely affect the operation of implantable cardiac pacemakers.

The study, which was conducted at the Thoracic and Cardiovascular Institute at Michigan State University, tested the effects of the iPod on 100 patients with pacemakers (mean age, 77 years old). When the iPod was held two inches away from the patient's chest for 5 to 10 seconds, electrical interference was detected in half of the test subjects. In one reported case, electrical interference created by the iPod caused a pacemaker to stop functioning altogether.

The lead author of the study, Jay Thaker, is a student at Okemos High School in Okemos, Michigan, whose curiosity about possible interference led him to Dr. Krit Jongnarangsin, an assistant professor in the Division of Cardiovascular Medicine at the University of Michigan (who also happens to be a long-time friend of Thaker's father), who helped Thaker conduct the investigation.

Jongnarangsin, who is the senior author of the study, noted that "most pacemaker patients are not iPod users," but conceded that the issue requires further study.

(*Copied entire from the Product Safety section of Conformity magazine, "*iPods May Cause Pacemaker Malfunction" *Jul 26, 2007, Conformityhttp://www.conformity.com/newsman/publish/printer_534.shtml)*

472) Interference with marine diesel shoots jets of flame

In the mid-1990s I was visiting a company that made automatic speed control systems for large internal combustion engines, such as used to drive small electricity generators and marine engines. Their system used a tachogenerator to measure the motor's rotational speed, fed that into an opamp which compared it with a reference voltage (the 'Set Speed') and the error output was amplified and used to alter the rate at which fuel was injected.

Their Managing Director told me about an interference incident he had witnessed with one of their products controlling the speed of a large marine diesel engine. These engines have huge cylinders, maybe several litres capacity each, and a very slow rotational speed. They were in the engine room and one of the vessel's crew operated his walkie-talkie. The fuel injection control immediately slammed over to full rate injection, flooding the cylinders with much more diesel fuel than they could handle.

As each cylinder came up to top dead centre the burst valves operated to protect the engine from damage, and blasts of flame several feet long shot across the engine room – making the engine into a sort of sequentially-pulsed flame thrower. Luckily, no one was in the way of the flames, so fire was started and nothing was damaged. Since that incident, they have applied significant electromagnetic filtering and shielding to their products.

(*Sent in by an EMC consultant who wishes to remain anonymous. We find that if you can get EMC consultants and EMC Test Laboratory managers into a reflective mood they all have a huge store of anecdotes that are as exotic or surprising as the one above. A significant number of their anecdotes* *concern safety risks that they reduced by dealing with interference problems that had been noticed before they had resulted in a serious accident.*

But consultants and laboratory managers are constrained by 'client confidentiality' from discussing the work that they do, and so almost no-one gets to hear about them, and the same mistakes get made over and over again. We encourage all EMC consultants and test laboratory managers to send their anecdotes for publication in Banana Skins – if they can do so in a way that does not conflict with their duty of confidentiality to their clients. We are happy to publish such anecdotes with the submitters full name and affiliation, or just with their name, or anonymously.)

473) Lighting strike to a small boat

As an avid sailor, I recently had an unusual experience with lightning and its search for "ground". I was in a 30 foot sailboat that was struck at dock. I'm told that in a lightning strike at sea, its common for the path to ground to be through a "through hull", a brass fitting in the hull of the boat, being the end of a plumbing line. The path will be through the plumbing line and blow out the fitting, sometimes sinking the boat.

I was at dock with shore power connected when the 35 foot metal mast took a direct hit. It physically blew the comm station all about the boat cabin. Everything was toast. Upon rewiring, much of the wiring was just gone! The path to ground jumped from the DC circuit to the AC circuit and traveled up the shore power cable. The cable, 1" diameter, blew out, exploded, in a "pattern" of every four feet until the connection to shore power. It welded itself to the boat railing it was laid across. And then blew out every other power meter on the dock (about 40 slips).

It was quite a shocking experience! $12k later, the boat is fine, but I'm still nervous in storms. Lucky I was connected to shore.

(Extracted from a posting on the IEEE's emc-pstc, emc-pstc@majordomo.ieee.org, by Scott Proffitt, of Advanced Compliance Solutions, Inc., www.acstestlab.com, on 3rd April 2002.)

474) Fibreglass airplane shocks pilot

On May 23rd 1987 Dick Kreidel was flying a small airplane with a body made of composite (glass-fibre) and upon entering a region with thunder clouds experienced a number of instrument malfunctions and various electric shocks to his body. Eventually he landed safely.

For more on this, see Dick's report (and a response from a lightning expert, J.A. Plumer of Lightning Technologies, Inc.) at www.ez.org/cp53-p10.htm. See Dick's plane at www.wingco.com.

475) Lightning finds strange paths to earth

A year or so ago, I met a retired IBMer and his wife whose teen-age son was stuck and killed some years ago by lightning in the outfield of a baseball game that had just begun. Other than some distant clouds, there was no warning that this might happen, no rain or thunder.

Now, I have just learned of the severe lightning damage done to the home of a guy I managed in the '80s. I have pasted his account below, with comments in brackets [ ] of additional damage findings. It is evidence of the sheer power in a lightning bolt, and the strange paths it chooses to follow in attempting to establish the "best" path between the sky and "good" earth ground.

Friday [March 29] around 3:15pm my house was hit by lightning. Right now we're in a motel up the road because we don't have any electricity (light, heat or phones). The utility company pulled the meter to inspect and won't reinstall until house wiring is inspected. Due to the Easter weekend we couldn't get anyone out before Monday.

The bolt hit in yard blowing two bushes completely out of ground then jumped into the rear wheel of my Corvette melting spots on both rear mag wheels as it went through and melting the car cover near wheels. It blew several huge holes in cement driveway and then hit my garage where it blew out outlets and switches, blew drywall and insulation completely across garage, blew out garage window, structurally damaged garage door & brick pillar that supports it and tore gutters and a section of garage roof at corner off house. The new heat pump is fried along with phone lines, cable lines.

475, There's also a hole in living room ceiling and several other holes in roof. Pieces of my driveway rained down on the house, two large chunks came through roof and living room ceiling while the other chunk came down above our bedroom, hit a rafter and stayed in attic. My garage was full of smoke but no fires, just insulation and wood that was seared. The Fire dept. used an infrared camera to make sure nothing was continuing to burn in wall and they covered holes in roof. We've found large chunks of driveway completely imbedded in neighbor's yard 150' from hole in driveway.

My neighbor was out working in his backyard about 250' away and said the bolt hit just when he dug into ground with a shovel, sparks flew from shovel and he has bruises on his arms from jolt and was hit by small pieces of flying cement from my driveway. At first he wondered what he had hit with his shovel. Several people on street lost computers, phone lines and cable. The technician said it took out a whole section of county, 1000 customers and my house was ground zero.

[Later evidence seems to indicate a complicated path for the lightning to reach a good earth ground, probably the buried water or sewer pipes in the street. It seems to have hit metal gutter above garage, traveled several feet before "jumping" to house vertical wiring near the garage door, downward to the metal angle iron along bottom of door, then "leapt" to steel re-bar in the concrete driveway, to the end of the re-bar and then to a wheel on the car parked there, thru the car body and back to more re-bar in the concrete, then under the shrubs, possibly heading for the buried street utilities. Two craters in the driveway indicate where it entered and exited the encased re-bar.]

*(Copied from: "*Danger and Power of Lightning*", posted on emc-pstc@ieee.org by George Alspurgh, 2nd April 2002.)*

476) Another lightning story

The Broward County (Florida) Civil Defense office had a 180 foot radio tower that was several years old before it was finally hit by lighting (this was many years ago). It turns out the tower was not grounded.

The lightning came down the heliax coaxial cables, about 2 inches in diameter (no cm back then), into the building. One of the (vacuum tube, remember those?) VHF radios looked like the speaker grille was hit by a fist from behind. The CD director's telephone was melted on the desk. All the electrical outlets were burned and the air-raid siren relay was welded 'on'. The siren activated and would not turn off.

The only person in the office was a secretary who knew nothing about electricity. I think she must have aged 10 years in 2 seconds that day. I was in high school at the time and came to realize at a tender age that there is no such thing as a 'lightning protector'.

*(Copied from: "*Another lightning story*" in the thread "Danger and Power of Lightning", posted on emc-pstc@ieee.org by Douglas C. Smith, 2nd April 2002.)*

477) Black Hawk helicopter crashes

In the mid 1980s, the US Army experienced 29 crashes of its UH-60 Black Hawk helicopters, at least five of which were believed to be due to RFI. The helicopter exhibited flashing indicator lights, unintended movement of the stabilator and other responses when it was near radar transmitters and microwave towers.

The US Navy also flies UH-60s under the name of Sea Hawks, but experienced no RFI incidents. The Navy had the chopper's manufacturer use additional shielding to meet greater electromagnetic ambient requirements. Eventually, the Army retrofitted its helicopters with additional shielding.

*(Taken from Don White's 1998 EMC Encyclopaedia CD-ROM, '*Case Histories, EMI-related (a tutorial)*', published by EMF-EMI Control, Inc.)*

478) Electric guitar in studio is jammed by taxicab CB transmitter

A broadcast studio, located in downtown Manhattan, was experiencing a periodic interference to its electric guitars. Subsequently it was discovered that nearby taxicabs, equipped with illegal 1,000 watt CB transmitter amplifiers, were the culprit.

Shielding the street side of the studio would have removed the RFI demodulation problem, but the manufacturer had used unshielded and unprotected guitar cables. Adding clamp-on ferrites at the guitar input leads was the more economical fix. Shielded cable replacement or filter pin connectors would also have worked.

(*Taken from Don White's 1998 EMC Encyclopaedia CD-ROM, '*Case Histories, EMI-related (a tutorial)*', published by EMF-EMI Control, Inc.)*

479) Taxicabs' transmitters interfere with computer room during rainy weather

Off the entrance foyer inside from the marquee is located a computer accounting room. The customer complained of computer crashes during rainy weather.

After letting off a customer, a taxicab calls the base station dispatcher for his next customer pick up. This is done while the cab is under the marquee, about 12 meters from the computer room.

Since the victims are so expansive, with multiple wiring distributed under the raised flooring, a simple protection scheme was not economical. Instead, the fix involved shielding the marquee side of the computer room.

*(Taken from Don White's 1998 EMC Encyclopaedia CD-ROM, '*Case Histories, EMI-related (a tutorial)*', published by EMF-EMI Control, Inc.)*

480) Truck's brakes lock up due to interference, 13 teenagers killed

In the late 1980s, a truck, skidding out of control, crashed into an ice cream parlor in Munich, killing 13 teenagers and injuring others. Subsequent examination indicated that the truck's anti-skid breaks locked up when near certain type transmitters.

(Note: This kind of an EMI problem became well known in the late 1980s. It would not likely happen today, since automobile manufacturers now design to harden their vehicle wiring and modules to cope, and test whole vehicles to 200 V/m).

(*Taken from Don White's 1998 EMC Encyclopaedia CD-ROM, '*Case Histories, EMI-related (a tutorial)*', published by EMF-EMI Control, Inc.)*

481) FDA Cautions User of Implantable Devices About RFIDs

The U.S. Food and Drug Administration (FDA) is cautioning consumers with pacemakers and other implantable medical devices about the potential for interference from radio frequency identification (RFID) tags.

RFID tags are gaining widespread use in inventory control, employee identification programs and transportation fare collection systems. But, implantable medical devices can be susceptible to interference from radio frequency sources, including RFID tags, resulting in malfunctions and even device failures.

The FDA cautions consumers with such devices to be vigilant about potential interactions between their device and RFID tags, and to leave any area immediately when experiencing physical symptoms that indicate that their device is not working properly.

View the complete text of the FDA's notice about RFID at www.fda.gov/cdrh/rfid.

(*Copied from "*FDA Cautions User of Implantable Devices About RFIDs*", Conformity magazine's on-line newsletter, Jun 28th, 2007 - 10:57:43 , www.conformity.com)*

482) Nissan warns U.S. cellphones can disable car keys

Some owners of 2007 Nissan Altima and Infiniti G35 sedans have found that if their cellphones and 'intelligent' car keys (known as I-Key) are touching, incoming or outgoing calls can alter the electronic code in the I-Key with the result that the car will not start. The I-Key cannot subsequently be reprogrammed.

So Nissan is asking customers of these models to keep their car keys and cellphones at least an inch apart to avoid disabling the I-Keys. For more on this, visit: http://uk.reuters.com/article/technologyNews/idUKN2424455020070524.

(*Sent in by Graham Barber, Principal Policy Advisor, The Institution of Engineering and Technology, www.thiet.org. Also see Banana Skin No. 335, which suggest that the problem is not limited to these two Nissan models.)*

483) Variable speed motor drive interferes with plastics moulding machine

The moulding machines concerned use high pressures and high temperatures to mould the plastic parts, and are about the size (and general shape) of the boiler of an old-fashioned steam railway locomotive. They use powerful AC motors to drive their pressure systems, but the pressure demand is not constant, so much of the motor power is wasted in recirculation.

To reduce electricity consumption, save money and help save the planet, the owner tried fitting a 100kW variable-speed AC motor drive to one of the machines, but whenever the drive was operated the moulding machine suffered interference to its temperature control systems. The result was that the plastic parts were deformed because either they were moulded at temperatures that were too high or too low.

The problem was solved by fitting a suitable mains filter to the drive, with the filter's case bolted directly to the chassis (several types of mains filters were tried, but most proved useless) and also by installing a shielded flexible conduit over the motor cable, bonded directly using EMC shielding glands to both the motor frame (at the terminal box) and to the drive unit's chassis. Neither of these techniques had any effect on their own, they both needed to be applied together, which is typical of suppressing EMI from variable-speed drives.

(Submitted *by an EMC Consultant who wishes to remain anonymous.)*

484) CD players interfere with VHF wireless microphones

The typical hi-fi style CD player produces interference on 175.000 MHz radio microphones. Basically, if you are using a radio microphone on this frequency, which is very common on the older VHF equipment, you need about a metre separation from any CD player. This is both inconvenient in a typical installation and CD players get moved around by users. Thankfully, UHF radio mics don't suffer from this problem.

(*Sent in by Robert Higginson, 11th August 2007)*

485) Many CE-marked products don't comply – EU market surveillance to increase

A recent study published in Science reveals that societal models for cooperation are doomed to vanish if the number of level-playing incidents (for example, those manufacturers that do not comply to CE rules, or "free riders" becomes too high. In that situation the model becomes untenable.

From a study performed by ANEC (the European Association for the coordination of Consumer Representation in Standardization) in 2005, we note following alarming issues:

- Manufacturers do not mark their equipment with the CE mark
  (a criminal offense: refer to the New Approach guidance document referenced above);
- Manufacturers do put the CE mark on their equipment, but required technical documentation and/or the DoC are completely or partially missing (also a criminal offense).

Data on market surveillance actions performed by authorities in Sweden, Germany, Finland and the UK show that percentages of non-conforming products are higher than 15% (the reference number which was used in the societal study referred to above). Rates of non-conforming products in these countries were 28.5%, 50%, 37.5% and 33% respectively.

In summary, the above suggests that the very reputation of the CE marking scheme is at stake.

This and other reasons prompted the European Commission to review the workings of the New Approach Directives, and consultations with stakeholders were held from 1998-2002. In 2005, a proposal was published on the EC web site, referred to as "Elements for a horizontal legislative approach to technical harmonization" (CERTIF 2005/16 rev 2).

The solution, according to this proposal? A horizontal legislation directive for all New Approach Directives.

In brief, the proposal suggests changes to:

- Basic notions and definitions (e.g. placing on the market);
- Conformity assessment bodies and facilities ('essential requirements' for them);
- A reinforced implementation and role for accreditation;
- Conformity assessment procedures (the 'modules' are changed);
- Market surveillance reinforcement.

The proposed timing to implement this horizontal legislation directive is as follows:

- Initiated by the European Council on 10 November 2003;
- The EC prepared CERTIF5 documents;
- Public consultation ended on 26 July 2006;
- EC is now preparing a legal proposal (*6377/07, published 15th February 2007, see below – Editor*);
- New horizontal framework directive to be published in 2007 or 2008.

*(From "*The Future of Market Surveillance for Technical Products in Europe*", by Ivan Hendrikx, Conformity, www.conformity.com, Apr 1, 2007 (but not an April Fool's joke!), http://www.conformity.com/artman/publish/article_158.shtml.)*

*(The Council of the European Union Interinstitutional File 2007/0029 (COD), 6377/07, 15 February 2007, "*Proposal for a Regulation of the European Parliament and of the Council setting out the requirements for accreditation and market surveillance relating to the marketing of products*", is at http://register.consilium.europa.eu/pdf/en/07/st06/st06377.en07.pdf.)*

(The editor notes that the fact that many CE marked products don't actually comply with the EMC Directive, and (as other studies have shown) about the same proportion have questionable compliance, is one reason why the simplistic CE + CE = CE approach cannot ensure compliance of the finished equipment, system or installation.)

486) Underground transportation system malfunctions and damage

A public underground railway line suffered from regular interruptions in service during rush hour periods, and there were some cases of damage to its DC rectifiers. The mains was supplied at 120kV, with a switched capacitor bank to correct power factor as the load varied. The 120kV was stepped down via a number of 12kV transformers, each of which could supply up to 5 DC converter stations spread up to 19km along the railway line.

Special protection relays were installed in the DC converter substations to quickly detect flat tyres on the trains and protect the DC converters from the resulting short-circuits. Switching the 120kV switched capacitor bank regularly occurred during rush hours, and caused high-frequency oscillations to be superimposed on the normal supply waveform. The special protection relays were found to be very sensitive to these high frequency oscillations, and this was the cause of the regular interruptions in service.

It was also found that some of the breakers associated with the 120kV switched capacitor bank were faulty and prone to restriking the arc. Under some circumstances this restriking caused overvoltage surge of over 250kV – enough to damage the insulation of the cables. This was the cause of the damage to the DC converter rectifiers.

(*Derived from subclause 9.2 of IEC/TR 61000-2-14:2006,*"Environment – Overvoltages on public electricity distribution networks"*, Clause 9: "Case Studies", www.iec.ch)*

487) Palmtop computer interferes with aircraft collision avoidance system

Synopsis: DC-9 flight crew received a false TCAS RA during departure climb and increased their rate of climb to avoid a false target apparently generated by a passenger's palmtop computer.

TCAS = Traffic Collision Avoidance System, RA = Resolution Advisory (a recommended avoidance measure)

Narrative: During climb while talking to SDF departures, we got a TCAS RA showing a target at 12:00 o'clock, level and showing a climb. TCASII commanded a full-scale (6000 feet per minute) climb and I as PF increased climb rate to 3000 feet per minute (the maximum we could safely do). We called SDF departures to repeat the RA and ask about the target. He said he had no target within 5 miles of us, so I hit the TCAS 'press to test' button. TCAS reported 'Test OK'. I then asked the lead flight attendant to do a PED walk and he reported back that a computer was in use in violation of the sterile environment condition. The computer, a 'Dell Inspiration 8000', with reportedly no transmission capability and no external power pack, was shutdown for the remainder of the flight and TCAS functioned normally with no further false RA's or TA's.

The reported believes that the issue of reliability of the TCAS system during a scenario such as this is a key safety issue.

(*The above report is extracted from the 23rd January 2007 ASRS Report, No. 579608, http://asrs.arc.nasa.gov/report_sets/ped.pdf. See Banana Skin number 467 for more information on NASA's ASRS reports.*

http://en.wikipedia.org/wiki/Traffic_Collision_Avoidance_System says (on 10th August 2007): The Traffic alert and Collision Avoidance System (or TCAS) is a computerised avionics device which is designed to reduce the danger of mid-air collisions between aircraft. It monitors the airspace around an aircraft, independent of air traffic control, and warns pilots of the presence of other aircraft which may present a threat of mid-air collision (MAC).)

488) Aircraft navigation upset by passenger electronic devices

Synopsis: B727 flight crew experienced erratic VOR navigation course indicator possibly due to passengers' use of an electronic device.

Narrative: Shortly after our departure and giving the flight attendants the signal that it was OK for passengers to use personal electronic devices (PEDs), the #1 VOR OFF flag came in view and the course deviation indictor drove to full-scale deflection. The bearing pointer also began a slow drift away from the correct bearing.

This only lasted a few minutes while we were checking reception from other navaids, and then the VOR began working properly again. Then, shortly before beginning descent to our destination, the #1 VOR again began reacting in the same abnormal manner. I made an announcement to the passengers to discontinue use of PEDs and the VOR returned to normal almost immediately. VOR operation remained normal form the rest of the flight. Our flight attendants did confirm that PEDs were in use at the time of the second incident but due to our proximity to landing, we did not have time to do more investigation to see which specific device was at fault.

(*The above report is extracted from the 23rd January 2007 ASRS Report, No. 533768, http://asrs.arc.nasa.gov/report_sets/ped.pdf. See Banana Skin number 467 for more information on NASA's ASRS reports.)*

489) Giant World-cup display screens cause interference

During the 2002 World-cup and 2003 Universidiade sporting events in Seoul, South Korea, numerous giant display screens were installed at sports stadiums, subway and railway stations, highway toll-booths, etc. These screens used LED technology and could be more than 10 metres wide. Because they are each assembled on-site, and because of their large size, they cannot be tested in normal EMC test laboratories.

The operation of these giant LED screens caused complaints of interference from users of cell phones and radios, which were verified by the national authority. But because of the lack of detailed test methods and procedures for such large items, problems were encountered in enforcing the national EMI/EMS rules and regulations.

(*A summary of part of CISPR/H/81/NP, a new work item proposal for the development of in-situ emissions measurement techniques for large items of equipment, November 2003.)*

490) Interfering with multi-million dollar semiconductor machines

Remember that power-supply return, chassis common, and shielding ground have different requirements. You should avoid using the system's frame to return (power supply - Editor) current, as you would in the design of an automobile. (This auto-industry-standard approach also causes many EMC problems for motor cars, and is universally deprecated by all EMC engineers, for all types of applications – Editor).

Using the machine frame as a power-supply return is one reason that maintenance people cannot use FM radios in a semiconductor fab: doing so may cause the machinery to reboot or act unpredictably.

The problem is one of a classic ground loop, in which the shield in a coaxial cable carries the power-supply current and interferes with the signal by inducing a series voltage drop in the outer conductor (which makes it appear in series with the wanted signal – Editor). This approach can cause million-dollar semiconductor machines to crash when you stand next to them and key in a radio.

(E*xtracted from: "*Circulating Currents: the Warnings are Out*", Paul Rako, EDN Europe November 2006, pp 47-62, www.edn-europe.com.)*

491) Airborne interference with GPS

A program that measured the in-flight RF spectrum on 37 revenue flights of commercial aircraft is described. The spectrum monitoring was performed from gate-to-gate in selected aviation-critical and personal electronics frequency bands over the period from September 23 to November 19, 2003. The commercial aircraft in-flight RF environment for two critical navigation frequency bands, VOR and Global Positioning System (GPS) and four consumer electronics frequency ranges are reported. A brief analysis of the GPS band data is presented.

While the avionics community specifically attempts to avoid emissions in the GPS band, this study revealed onboard signal activity. There were signals observed on 58 of 196 traces and creates the potential for interference. As future dependence on GPS grows, i.e. precision approaches, the threat posed by such interference will become more serious. Thus any observed signals should raise concern.

GPs will play a much greater role in future systems for navigation and precision approach. The FAA is ‘aggressively implementing’ GPS into critical aviation functions [32]. This includes navigation in the en route, terminal area, approach/landing, and surface operating regimes. The potential for GPS interference takes on new criticality in the context of precision approach. The needed exposure times on approach are relatively short (~ 150 seconds), but system continuity and integrity requirements are stringent [28]. The observed signal with a negative safety margin, the potential of undervalued signals and the high rate of observed signals all suggest that this is an issue that warrants careful future attention.

[32] Geyr, M. and Frazier, R. “FAA GPS RFI Mitigation Program.” ION GPS-99, 12th International Technical Meeting of the Satellite Division of the Institute of Navigation, September 14-17, 1999, page 107, http://www.ion.org/publications/toc/99gpstoc.html.

[28] Erlandson, R.J. “Susceptibility of GNSS Sensors to RFI.” 15th Digital Avionics Systems Conference, October 1996, pp 273-278. (Summary: A derivation from basic principles is presented of GLONASS receiver in-band susceptibility levels suitable for Category I approach use. The derived limits are -113.5 dBm for interference bandwidths less than 500 kHz and -110.5 dBm/MHz for greater than 500 kHz. The limits are more stringent at the wide and narrow bandwidth extremes than the existing ARINC standard. Also derived are wide and narrow bandwidth GPS limits which are consistent with RTCA/DO-229 except for a 2 dB lower CW level.)

*(Extracted from “*The Onboard Commercial Aircraft In-Flight RF Environment*”, Bill Strauss, IEEE 2006 International Symposium on Electromagnetic Compatibility, Portland, OR, Aug 14-18 2006.*

The Editor is continually surprised at the evident eagerness to use the unreliable GPS system for safety-critical applications, such as landing aircraft (see above). Are the manufacturers and organisations concerned taking the serious issues mentioned in Banana Skins 29, 98, 119, 134, 207, 222-224, 227-232, 238, 278, 291, 357, 363, 371, 388, 415, 420 fully into account to achieve the level of safety that people generally have the right to expect? Or are they just focussing on the low cost?

For more information on the use of GPS in transportation infrastructure, visit: http://www.volpe.dot.gov/gps/index.html. A list of documents on GPS and transportation is available at: http://www.volpe.dot.gov/gps/pubs2.html. Another useful site is http://www.ion.org/meetings/past/gps2001/a1.html.)

492) Hazards of interference with prosthetics

Christine Evans-Pughe’s article on smart prosthetics on the June 2006 issue of Engineering & Technology made interesting reading, all the more so when I read that a “fully integrated 433MHz transmitter” was being used.

These frequencies are in widespread use by car locking fobs and radio amateurs as well as the UK Ministry of Defence. Some interference is already observed between these users, I am getting visions of a soldier operating a radio, or a driver entering a car, only to cut short their endeavours as a result of strangling themselves with their prosthetic hands.

(*From “*Prosthetic Interference Hazards*”, Feedback, IET Engineering & Technology, July 2006, page 6, www.theiet.org/engtechmag.)*

493) Immunity problems with consumer appliances

Instances of Electromagnetic Interference. In the 1950s and 1960s, the design of transformer-less AC/DC type broadcast receivers caused considerable grief to transmitter owners. Eliminating the power transformer solved one problem but created another for those close to a transmitter. Called “swamping” then, it is now called overload. Then, in the mid-1970s, there were about 30,000 reported cases of radio interference in Canada involving consumer electronic products (it has been estimated that these cases represented 7-10% of total cases in the U.S.).

Other reports over the years involve intercom systems installed in a new residential development north of Toronto, which picked up FM signals from the CN Tower—about 26 miles away! Most wired intercoms don’t operate with FM. but here it was difficult to remove.

During the installation phase of an FM transmitter in Brockville Ontario (Canada), over 500 complaints were filed relating to interference with the operation of domestic products. A survey taken in the Barrhaven area of Ottawa Ontario in 1986 confirmed 600 complaints from an AM station located within

1000 feet of a residential area. Many of these results were to be expected, but the media focused primarily on the amusing side effects of the interference, such as the "talking card table " and the "talking water bed."

Over the years, I have found that manufacturers' efforts to ensure EMC in consumer electronics and appliances are largely voluntary, and complicated by the challenge of determining what standards, if any, apply. In fact, because Industry Canada no longer investigates or records consumer complaints of radio interference, there appears to be little incentive for manufacturers to ensure EMC immunity in their products.

How does interference manifest itself? What are some of today's most radiosensitive consumer products? The list includes televisions, stereo systems, telephones, intercoms, touch lamps, baby monitors, VCRs, electronic organs, furnace controls, alarm systems, active TV antennas, cordless phones, CD players and computer modems. Personal experience also supports the addition to this list of domestic gas range controllers, and it is incidences of gas range controller malfunctions associated with EMI and the potential safety hazards that those malfunctions pose that have prompted the writing of this article.

How do the effects of EMI on consumer electronics and appliances manifest themselves? In TV sets, for example, the effects include total blanking of the video, the loss of horizontal and vertical synch, and light cross-hatching or modulation bars. The extent of these unwanted effects depends on the frequency of the undesired signal mixing with the desired signal, but such effects are always visible. Undesired signals may also impair the audio quality, from total suppression of the audio feed to mixing with the desired program audio content. In many instances, both audio and video are affected.

In Canada, the landmark Hougthby-Ravenscoft case involved a radio amateur and began with a radiosensitive electric furnace controller. Every time that the operators transmitted Morse code, the furnace control relay keyed a 10kW load on and off with an alarming sound. At the same time, a black and white television lost synch with a mere 5 watts into the amateur operator's antenna. Measured field strength within the home was 0.7V/m (with 1kW input to the amateur's transmitter). That case took five years and over $80,000 in legal fees to wind its way through the court system. It seems that Mr. Linden's "Law of Torts" didn't take into account the laws of Physics and electromagnetic coupling.

The veritable rat's nest of wires behind the average stereo system has a large capture area to local radio fields, and may couple these directly to the solid state amplifiers connected to the speakers, resulting in audio rectification in the output transistor junctions. Speaker wires make excellent antennas and shielded leads are not always a solution to preventing such effects. It is not uncommon to hear these audible effects, even with the equipment turned off. I have heard AC/DC kitchen radios respond to 450 MHz when they shouldn't, even when achieving power line isolation is relatively easy to do.

Security control systems, such as intrusion alarms, motion sensors and, on occasion, outdoor klaxons, can react in a manner for which they have not been designed, including sporadic and unpredictable operation. I recall the indignation of neighbors when an outdoor klaxon (horn) blasted forth at 5 a.m., until it was finally manually silenced by the homeowner. Motion sensors are essentially diodes, and can rectify broadband RF and create false "intrusions" when so excited. Some electronic outdoor timers respond in similar fashion. Observing residential outside lights that turn on during daylight hours is a dead giveaway.

Finally, many of us remember how Air Force One would activate garage door openers in California, whenever U.S. President Nixon traveled there, providing his neighbors with advanced notice of his visit.

All of the examples I've cited above represent classic cases of lack of immunity or poor selectivity. However, in my experience of resolving over 300 consumer complaints due to amateur radio operation and or commercial broadcast facilities or embassies, 95% of such cases are easily resolvable.

(*Extracted from "*Interference Immunity in Consumer Products*" by Ralph Cameron, Conformity, March 2006, pp 12-17. The article includes many other case histories, and can be found at: www.conformity.com/artman/publish/printer_20.shtml or by searching the Conformity website www.conformity.com.)*

494) Audio induction loop monitors suffer digital interference

The Audio Frequency Induction Loop is a means of magnetic coupling of a clean audio signal into a hearing aid. This bypasses the hearing aid's own microphone, and so removes unwanted sounds such as a conversation behind the hearing aid user. A coil of wire around the required listening area is driven with a current as if it were a loudspeaker. The resulting magnetic field is picked up by a coil in the hearing aid, known as a 'T-coil'. For testing, and for use by those without hearing aids, a 'loop monitor' may be used. They have T-coils and headphone amplifiers, and either ordinary headphones, or the in-ear phones common with MP3 players can be plugged into them.

In a recent induction loop installation in a Quaker Meeting House, several loop monitors were provided for use by people who did not have hearing aids. The loop monitors were an industry standard product made by a reputable manufacturer, but suffered from considerable levels of audible 'digital' interference wherever they were used in the meeting room.

The audible noise was not turned down by the volume control, so was not caused by the audio induction loop signal. Suspicion fell on mobile phone aerials on top of a building well under a quarter of a mile away. Moving the headphones to orient their wires with respect to the mobile phone antennas, effectively using them as radio antennas (as they are used by the FM receivers that are a common feature of many MP3 players) could vary the interference from negligible to intrusive.

So it seems that the headphone wires were picking up the RF transmissions from the nearby mobile phone aerials, injecting the RF signals into the outputs of the headphone amplifiers, which then demodulated the RF signals and outputted the resulting 'digital' modulation envelope – which of course was in the audio frequency range and the cause of the annoying noise – to the headphones.

I wonder if the loop monitors had ever been tested to the radiated RF immunity tests under the EMC Directive? The field strength from the mobile phone antennas was almost certainly less than 3V/m, the test level used in such tests.

(*By Keith Armstrong of Cherry Clough Consultants, www.cherryclough.com, summarising an August 2007 discussion with Robert Higginson of AREAC Midlands Ltd., www.areac.co.uk.)*

495) Electromagnetic Interference…an Achilles Heel for the U.S. Department of Defense

As an organization, we in the Department of Defense (DoD) fall short in our ability to detect, characterize, report and resolve electromagnetic interference or EMI. EMI is a combination of terms that broadly refers to any type of interference that can potentially disrupt, degrade or otherwise interfere with authorized electronic emissions over approved portions of the electromagnetic spectrum. Some are probably more familiar with the term "radio-frequency interference (RFI)," which is actually a specific type of EMI.

We don't have an effective means to swiftly combat and overcome EMI—detection and characterization of offending signals. Reporting and tracking of incidents, geographical location and identification of sources, and resolution are all essential phases in working an EMI event. Mitigation is also a very important part of the process. Furthermore, growing competition for portions of the frequency spectrum and equipment limitations make our ability to operate through EMI increasingly problematic.

By increasing widespread awareness and garnering upper-level support, our collective attitude toward EMI will improve giving rise to a much more effective EMI mechanism within the DoD. Our capacity for EMI mitigation and resolution is a very critical issue, basic to the successful accomplishment of the DoD mission. Whether this serves as an epiphany, confirmation of something you already know, or a point of contention, we simply cannot ignore how EMI regularly affects our operations with potentially crippling possibilities.

(*Extracted from "*Electromagnetic Interference…an Achilles Heel*", by CWO4 Todd D. Conley, U.S. Navy, 2001, http://www.chips.navy.mil/archives/01_fall/electromagnetic_interference.htm.)*

496) Fish fryer in Feltham

A frying machine at a fish restaurant in Feltham, which is near the flight path for Heathrow Airport's Runway 1, emitted RF interference. When they were testing the instrument landing systems on Trident aircraft, they tended to land earlier than they should have when the fryer was operating.

(*Sent in by Dave Imeson of Compliance Europe Ltd. Dave is also the Secretary of the EMC Test Labs Association, www.emctla.co.uk, whose website includes a large number of Technical Guidance Notes* *and other documents useful for test laboratories.Landing earlier can be a big safety problem, if the start of the runway has not yet been reached!)*

497) Monitor image jitter caused by faulty building wiring

At a local council office providing office accommodation for around 700 staff, the image on computer monitor screens used throughout the building by office staff had been progressively deteriorating. The image presented on the screen 'jittered' with words and pictures moving rapidly up and down the screen with no operator intervention and caused dizziness and nausea to operators. The level of jitter on each screen varied from irritating in some offices, to total illegibility in others.

A survey using an ELF meter (20-400Hz bandwidth) made evident that there was a 50Hz problem with field levels of 40-200mG measured throughout the building. Further investigation revealed that the source of the problem was located at a small power distribution board in the basement of the building. A current clamp placed around the cables showed that the neutral and earth were carrying currents significantly larger than the live (30A in one neutral with only 2A in its associated live). It was apparent that there was a significant number of wiring faults and this was causing the large magnetic fields.

Electrical engineers were then instructed and over the next few days the various wiring faults were systematically identified and corrected, and with a corresponding reduction in the level of magnetic fields and associated interference the jitter problem was resolved.

(*Extracted from "*A Guide to Performing EMC Site Surveys, with Case Studies*", by Rob St-John James of Hursley EMC UK, http://www.hursley-emc.co.uk, EMC-UK 2004, Newbury, U.K., October 18-19 2004, www.emcuk.co.uk/conference.)*

498) Interference with gas cooker control creates safety risks

In one particular Canadian community, many residents had complained over a number of years about interference with gas cooking ranges and other appliances located in their homes. In March 2004, for instance, one resident found that her range was intermittently being programmed, followed by the oven operating at random temperatures. It usually remained in this mode until manually turned off.

Similarly, in March 2005, another resident found that she had no control over the functions of her gas range, other than the ability to turn the range on or off. A third complaint was registered in October 2005, involving a range of the same model, type and manufacturer. This particular range had been operating reliably for the prior four years in another a residential community west of Toronto. By coincidence, the homeowner in this instance was located next door to the resident involved in the second incident noted above.

The residents had no prior knowledge of what might have caused the effects that they experienced (the developer who built the community had told them that they were located too close to the airport!). Imagine their surprise upon learning that the actual source of their problems was that AM transmitter located half a kilometer away. Their surprise was even greater when they found out that the transmitter causing the interference was actually legally operating within the terms of its license.

Fortunately, all three of these potential fire hazards were resolved satisfactorily (I describe the solution later in this article). But how many more ranges of the same type and model are out there, waiting for the "right" interference signal to cause a malfunction, perhaps even a disastrous one?

(*Extracted from "*Interference Immunity in Consumer Products*" by Ralph Cameron, Conformity, March 2006, pp 12-17. The article includes many other case histories, and can be found at: www.conformity.com/artman/publish/printer_20.shtml or by searching the Conformity website www.conformity.com.)*

499) RF welder stops factory

A supplier of specialist RF welding equipment for plastics had installed a new machine at a processing factory; the 3kW welding machine used RF in the 27MHz ISM band. The welding machine….was installed in a highly automated manufacturing line as part of a pilot scheme for a new manufacturing process.

When the welder was powered up and began to operate, not only did the pilot scheme not function but the other established manufacturing processes within the factory ceased to operate properly. The RF welder was identified as the culprit and the supplier came under considerable pressure to resolve the problem.

Using a spectrum analyser the RF survey confirmed that the RF welder was producing RF fields in the order of 3-6V/m. Closer inspection showed that the RF welder had a short low-impedance path from the RF generator but the return path was though wires to the chassis of the assembly line and conveyor belt system.

The long length (5-15m) of the return path through wires and the conveyor system was creating an antenna at the wavelength of around 27MHz. By isolating the RF welder return path from the chassis of the assembly line and providing an intentionally short low-impedance return path (using copper straps) the field level dropped to below 1V/m. In combination with a few ferrites placed on sensitive analogue transducer cables, a solution was achieved.

(*Extracted from “*A Guide to Performing EMC Site Surveys, with Case Studies*”, by Rob St-John James of Hursley EMC UK, http://www.hursley-emc.co.uk, EMC-UK 2004, Newbury, U.K., October 18-19 2004, www.emcuk.co.uk/conference. Contact Pam at pam@nutwood.eu.com for a copy of the Proceedings.)*

500) Love, Energy Medicine, Frequencies and Flowers

How does energy medicine work? Isn't it the same as thought medicine? What energies comprise body and mind? We know the body is made of particles, in some views, or waves of energy from other viewpoints.

Is there a scientific instrument (other than the human mind) precise enough to measure the smallest particle—the one that underlies measurable wave forms of energy? Not so far. Therefore physicists sometimes describe the fundamental units of physical energy so far discovered as being dual in nature: particles and/or waves, depending upon the viewing instrument. Ultimately, will scientists view an ultimate particle, an adamantine particle that is alive, yet not a wave form? We'll see, but what about the mind?

The human mind has been described as two-fold, consisting of
1. The brain, a DNA constructed, thought receiving and transmitting instrument
2. An electromagnetic field.

Being partially an electromagnetic field, within the Einsteinian Unified and infinite Field, gives the human mind a unique property: Infinite expandability — and the ability to access the Infinite storehouse of all that is imagined to be in universal, or unified consciousness.

(We always try to use an amusing or off-beat item for every 100th Banana Skin. The above is extracted from “Love, Energy Medicine, Frequencies and Flowers” by Scott E. Miners, *http://www.wellbeingjournal.com/index.php?option=com_content&task=view&id=49&Itemid=1for*, or else: http://www.lightparty.com/Health/LoveEnergyFlowerMedicine.html)

501) RFID ‘radio tags’ can interfere with hospital equipment

Lifesaving equipment in hospitals may be switched off by radio-frequency devices used to track people and machines, Dutch scientists claim.

Radio frequency identification devices (RFIDs) are on the rise in healthcare, helping identify patients, and reveal the location of equipment. The Journal of the American Medical Association study found they could interfere with machines. But NHS computer specialists said RFIDs could eventually make patients safer.

There are two types of RFID, one which transmits information, and another, "passive", device which can be "read" by a powered machine when it is held nearby. They are small and cheap enough to be in everyday use in society, in everything from security and travel cards – such as London Transport's Oystercard, to anti-theft devices on goods in shops, and hospitals are starting to become aware of their potential.

At Heartlands Hospital in Birmingham, patients heading for the operating theatre wear an RFID wristband, so that even when anaesthetised, their full identity, including a picture, can be downloaded into a PDA held nearby.

The latest research, conducted at Vrije University in Amsterdam, tested the effect of holding both "passive" and powered RFIDs close to 41 medical devices, including ventilators, syringe pumps, dialysis machines and pacemakers. A total of 123 tests, three on each machine, were carried out, and 34 produced an "incident" in which the RFID appeared to have an effect – 24 of which were deemed either "significant" or "hazardous".

In some tests, RFIDs either switched off or changed the settings on mechanical ventilators, completely stopped the working of syringe pumps, caused external pacemakers to malfunction, and halted dialysis machines. The device did not have to be held right up to the machine to make this happen – some "hazardous" incidents happened when the RFID was more than 10 inches away.

Dr Donald Berwick, from the Institute of Healthcare Improvement in Cambridge, Massachusetts, said: "Design in isolation is risky – even the most seductive technology will interact in the tightly-coupled healthcare world in ways physicians and other members of the healthcare team had better understand, or they and their patients may pay a dear price."

A spokesman for NHS Connecting for Health, which manages various IT projects across the health service, said that RFIDs had the potential to deliver big improvements in patient safety, reducing mistakes caused by the wrong identification of patients. She said: "Any product such as this which is for use in a healthcare setting has to meet a standard which means it is very unlikely to interfere with medical equipment. "This risk is more likely to come from RFID tags from other sources - such as a travel card, a tag on clothing, or on another retail item."

A spokesman for the Medicines and Healthcare Products Regulatory Agency said that, as for mobile phone use, individual Trusts needed to make risk assessments about the use of RFIDs.

He said: "Despite much debate in the literature on the subject of electromagnetic interference (EMI) of medical devices by mobile telephones and other sources of radiofrequency transmission, the MHRA has received very few reports of adverse events caused by this problem over the last seven years or so. "Of those incidents reported, only a very small number have been proven to be as a direct result of EMI."

(*The above is the BBC News report “*Hospital risk from radio tags*” at http://news.bbc.co.uk/go/pr/fr/-/1/hi/health/7471008.stm. Download the free abstract for the JAMA article, and/or purchase the whole thing for US$15, from: http://jama.ama-assn.org/cgi/search?fulltext=Lieshout&quicksearch_submit.x=4&quicksearch_submit.y=7. The JAMA article was picked up by many other news media, including: http://uk.reuters.com/article/technologyNews/idUKL2451111220080625, www.spectrum.ieee.org/jun08/6405, www.newscientist.com/channel/health/dn14198-radio-id-tags-can-play-havoc-with-hospital-devices.html?feedId=online-news_rss20, www.eetimes.com/showArticle.jhtml?articleID=208800768, and www.ashe.org/ashe/codes/advisories. Thanks for all these links go to: Graham Barber, Principal Policy Advisor for the IET; Antony Anderson, independent forensic engineer and expert witness; Richard Hoad, Technical Leader EMES, QinetiQ, Chris Zombolas of EMC Technologies, Australia, and a senior healthcare professional in the UK who wishes to remain anonymous.*)

The Editor adds the following notes to the BBC News report above:

a) It seems possible that the problem is one of ‘reactive near-field’ interference. It is impossible to predict near-field emissions or immunity from far-field tests such as those used by the medical EMC standard IEC/EN 60601-1-2. Also see Banana Skin No. 423 “*Interference causes poisoning of patient*”.

b) The quote from the spokesman for NHS Connecting for Health intrigued our anonymous respondent, who emailed for clarification and got the following response (their spelling): "*It's the electro magentic compatability (EMC) standard - which means the RFID is safe to be used in medical environment and carries no risk of affecting medical equipment. The Medicinces and Health Regulatory Agency (MHRA) insists on this standard.*"

The standard they are referring to is IEC/EN 60601-1-2 – but it is not true to say that it removes all risks from EMI. On 23rd September 2005 the IEC’s medical standards committee TC 62 published 62A/509/DC: ‘*Deficiencies in the current edition of IEC 60601-1-2*” that included the following statement about IEC 60601-1-2: “….*safety with regard to electromagnetic influences is not adequately addressed.*” (my underlining).

Work on the 4th Edition of IEC 60601-1-2 is under way with the intention of creating a ‘proper’ EMC safety standard, but it will not be published until at least 2009, so would not become mandatory under the EU Medical Devices Directive until at least 2011. It will probably be long after 2020 before at least half of the RFID and medical devices in use meet this 4th Edition.

c) The quotation from a spokesman for the Medicines and Healthcare Products Regulatory Agency that ends the BBC News report is a classic example of the fallacious argument beloved by politicians, known as the ‘absence of proof = proof of absence’ argument. Representatives of the US Food and

Drug Administration have admitted publicly that if EMI was a problem in US hospitals, they would not know about it because they do not collect the necessary data, and the UK's NHS is no different.

So we should not mistake the spokesman's careful words above as meaning that we do not have a problem. It simply means that we don't know if we have a problem or not.

The annual IEEE International EMC Symposium is always a good place to pick up Banana Skins, and this year's, held in Detroit, was no exception. It was nice to discover that many of the 'movers and shakers' in the EMC world read the EMC Journal, and that they especially appreciated this column! Numbers 502 to 507 are some of the anecdotes heard there (that are suitable for printing)…

502) Airport Instrument Landing System affected by bad batch of garage door openers

San Francisco Airport's ILS (Instrument Landing System) glide slope control was affected by a bad batch of wireless-controlled garage door openers sold to a new housing estate nearby. The super-regenerative oscillators in the receivers were unstable, and emitted radiation in the frequency band used by the ILS. The result was that planes coming in to land thought the runway was several feet lower than it really was, resulting in some very hard landings, potentially a serious safety risk.

(Kindly submitted by Harry H Hodes, of Acme Testing).

503) The EM environment in a lawyers' office

The average field strength in a law firm's office on 55th floor of a building just within Chicago's 'Loop' was between 3 and 5V/m.

(Mentioned by a participant in the session on The EM Environment, Friday afternoon 22nd August.)

504) Military planes exposed to Wi-Fi from LA

The communications dishes of military aircraft flying out of Edwards Air Force Base, are now picking up Wi-Fi from new suburbs of Los Angeles.

(Mentioned by a participant in the session on The EM Environment, Friday afternoon 22nd August.)

505) Lack of compatibility between medical EMC standards

The medical safety standard for HF surgery equipment (electro-surgery) sets no limits for the emissions from the equipment when it is operating. So there is no compatibility with the immunity of equipment covered by other medical standards, such as IEC 60601-1-2, even though all these standards come under one IEC committee, TC62.

The standard has an informative annexe that suggests checking the immunity of other equipment by wrapping the ES leads a few times around them, and operating it. But this would not have found the problem with the blood pump in Banana Skin 506 below, because the coupling was via the patient's bloodstream.

(Comment by Jeff Silberberg of the FDA, at the Friday afternoon session on The EM Environment, 22 August.)

506) FDA recall of blood pumps due to interference from electro-surgery

Please see the following link regarding a recall of a blood pump for susceptibility to HF surgery emissions: http://www.fda.gov/cdrh/recalls/recall-031708.html.

This device meets 60601-1-2, which of course does not assure immunity to HF surgery emissions.

The device was tested for immunity to HF surgery emissions, but not under the following conditions, which were confirmed to result in the pump stopping and alarming:

- with a Valleylab Force FX-C or Valleylab SSE2L in the coagulate mode with monopolar electrodes;
- with blood as a coupling path; and
- with the patient ungrounded.

The recall ordered by the FDA for the blood pumps was because, when electrosurgery was used and the patient was not grounded, RF energy coupled from the ES into the blood pump via the patient's blood.

The blood pump manufacturer thought it was acceptable to have a label that instructed the operator to reset the pump in such circumstances, but the FDA disagreed.

(Kindly supplied by Jeff Silberberg of the FDA, to the team working on IEC 60601-1-2, and as comments made at the Friday afternoon session on The EM Environment, 22 August.)

507) The US Navy bans the use of RFID in ordnance or pyrotechnic areas

(Mentioned during the presentation by Mike Slocum and Greg Tait on "Random Walk Technique: Measuring EME in Below-Deck Complex Cavities"*, at the Friday afternoon session on The EM Environment, 22nd August. Also see Banana Skin No. 501)*

508) Federal Commission Completes Report on Consequences of an EMP Attack

The Commission to Assess the Threat to the United States from Electromagnetic Pulse has issued a 208-page report detailing a grim scenario of cascading disasters as critical infrastructures fail. If terrorists were to obtain a nuclear weapon and to detonate it over the continental United States, every facet of modern life that depends on electricity would be impacted.

The authors point out a successful attack would affect the electrical grid, transportation, telecommunications, banking and finance, and access to petroleum and natural gas. The collapse of systems for delivering food and purified water to the populace would eventually undermine the social fabric.

The report calls for a concerted effort to plan ahead for such a disaster including a plan for the prolonged rebuilding process. Interestingly, one of its most emphatic recommendations is to work on a plan for communications and for keeping citizens informed. Stockpiles of food, water, and medical supplies are of little value unless people know of and report to facilities offering aid. The entire report can be viewed online at the Commission's website.

(From Interference Technology, 7th August 2008, http://www.interferencetechnology.com/lead-news/article/federal-commission-completes-report-on-consequences-of-an-emp-attack.html?tx_ttnews%5BbackPid%5D=1&cHash=7bad1cace5. Also see Banana Skin No. 448.)

509) Cool facts on 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 (3000 Hz to 30,000 Hz) "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 1000 Hz through VHF. Red Sprite Lightning has been associated with very powerful "Atmospheric Gamma Ray Bursts". Nuclear Radiation from Lightning Strikes!

(From "Extreme Currents" Volume 408, Military Edition, A newsletter dedicated to lightning and other extreme energy, http://www.nexteklightning.com/enews/408/coolfacts.htm 23rd May 2008)

510) EMI Causes Washington, DC Metro Trains to Switch to Manual Operation of Doors

The Washington Metropolitan Area Transit Authority has announced that for the immediate future the opening of all doors on its trains will be controlled by train operators.

On rare occasions, doors have opened on the wrong side of the car as the train comes to a stop at a station. This problem has occurred as Metro officials have been working to upgrade power substations and related infrastructure to produce enough electricity so that additional eight-car trains can be run to accommodate growing ridership demands.

Apparently, the upgrades are causing electromagnetic interference with the system that automatically opens the doors. The temporary fix is to have train operators open the doors manually overriding the automatic system. In the long term an electronic component will need to be installed in all of Metro's 1066 rail cars.

According to Metro Rail Chief Dave Kubicek, "While this problem happens only rarely, it is a safety concern. This has only happened four times in the last 22 million times that train doors have opened, but even one time is too many."

(From Interference Technology, http://www.interferencetechnology.com/emcnews/id1503, 25th April 2008. See the original announcement on the Metro website at: http://www.wmata.com/about/met_news/PressReleaseDetail.cfm?ReleaseID=2059.)

511) Audio amplifier goes 'clunk'

In a lab where a special-purpose computer was being tested, there was also a large audio amplifier with a toroidal mains transformer under test. The amplifier produced an audible 'clunk' at random intervals while the computer was running.

It turned out that when lightly-loaded at a mains voltage above 227 V, the SMPS went into a half-wave mode, clearly drawing current from the mains only on alternate half-cycles, of the same polarity. This means that even harmonics of the supply frequency are 'emitted' (or 'drawn', with opposite polarity), together with a DC component.

Very little DC is needed to magnetize a toroidal core, and the 'clunk' was caused by the core being magnetized by the DC component of the SMPS current.

There isn't, at present, any standard that has requirements to prevent this happening. But the solution to this problem doesn't fall neatly into IEC/EN 61000-3-2 or any other existing standard.

(Kindly sent in by John Woodgate, 17th October 2007, jmw@jmwa.demon.co.uk.)

512) Arc-welder emissions damage inverter drives

Like many large scientific and industrial sites, we can have people doing arc-welding on steelwork at various locations at any given time. They usually plug their welder into the building's normal mains supply, and do their welding outside.

I never used to think anything about this, until one day some arc-welding put so much noise onto the mains supply of the building I was working in, that it took out two variable-speed motor drive inverters. They had to be sent back to their manufacturer for repair.

*(Comment by a delegate during a course on "*Good Engineering Practices for the EMC Compliance of Fixed Installations with the New EMC Directive*", The Chequers Hotel, Newbury, 26th February 2008, run by Alan Warner aws-emc@talktalk.net.)*

513) Neighbours find ABC has turned the radio up too far

Residents living near the ABC's main radio transmitter at Liverpool have complained repeatedly of interference from the powerful signals it emits, amid concerns that planners have overlooked the impact of electromagnetic radiation on the area.

Residents in a new housing estate at Prestons, which is across the road from the tower, have had the signal from the ABC radio station 702 interrupting phone calls, throwing lines across television screens and turning electronic equipment on and off without warning.

"There would be music at the back of our phone calls," one resident, Arvin Prasad, said.

"Telstra kept saying it was not their problem but finally they fixed it. They put some kind of filter on the lines."

Another resident, Marina Baldin, said: "I had one of those touch lamps. It used to go off and one by itself. I got rid of it."

The Herald reported last week that the five AM radio transmitters at Homebush Bay will have to be moved because Planning NSW has given approval for a multistorey building 200 metres from the 2UE-2SM transmitter.

Scientists are divided about the long-term health risks of exposure to non-ionising electromagnetic radiation. No one is yet living at Homebush Bay, and the issue is who will pay the $40 million cost of moving the transmitters.

But at Prestons people have been living for more than a year in two-storey houses within 350 metres of the ABC tower. The ABC broadcasts at 50 kilowatts - ten times the power of the AM stations at Homebush.

(From an article by Anne Davies, Urban Affairs Editor, Sydney Morning Herald, www.smh.com.au, February 24 2003, sent in by Chris Zombolas of EMC Technologies Pty Ltd, www.emctech.com.au. Liverpool is in New South Wales, Australia, ABC is the Australian Broadcasting Company, and Telstra is the national telecommunications organisation.)

514) Church sound system creates a buzz

One church sound system installation included a DVD player for the video projector, with the audio linked into out mixer. I could hear a buzz which was clearly the picture signal breaking through into the audio. Usually this implies multiple earths creating some sort of a loop. However in this case the problem was cured when I added an earth from the mixer to the metal chassis of the DVD player. So we replaced the phono-to-phono leads with a different make. This got the buzz down to satisfactory levels (inaudible at normal settings).

Investigation after the fact showed that the original leads, which probably came as part of a CD or DVD player package, had insufficient copper in the "screen" to make a good earth. Indeed, some leads we have cut up to solder to equipment have not had a true screen at all. What we found was a few strands (about the same as in the core) of fine wire twisted to make a single core where the screen should have been. So some cables on the market are not what they seem and not fit for purpose as screened audio leads.

(Sent in by Robert Higginson on 16th August 2007. Robert has put his finger on an important issue that most EMC testers discover eventually – one cannot rely on the shielding effectiveness (SE) of most purchased cable assemblies. The issue is so pervasive and problematic, that advanced drafts of the second edition of the European Union's EMC Directive – 2004/108/EC – included requirements for compliance of 'ready-made connecting devices'. For example, COM(2002) 759 final, 2002/0306 (COD), dated 23.12.2002 said: "Ready-made connecting devices intended for the transmission of signals are, under certain conditions, deemed to be apparatus and subject to the essential requirements, the conformity assessment regime and the CE marking provisions of the Directive.")

515) Products interfering with broadband internet services are costly to discover

BT has investigated hundreds of cases where a product is causing significant interference to broadband services (and to radio services) but still functions to the user as intended. The cost for dealing with each case can be up to £15,000.

The reason for the degradation has been shown in some cases to be due component ageing due to poor design (almost always the X and Y capacitors in the mains filters).

If we believe the CE marking of the products was done correctly, then their emissions have increased by more than 60 dB during their normal lifetime.

(From the presentation by Martin Wright of BT, at the EMCIA/EMCTLA meeting: "Interpretation of the EMC Directive 2004/108/EC", held at Newbury, UK, on the 29th November 2007.)

516) TV emits 3V noise onto mains, stops ADSL over a large area

A test lab received a call from BT, concerning a problem that was blanking out their ADSL broadband internet services over an area of about a mile diameter. It had been discovered that a six year old television was the cause – when tested in the lab it was found to be putting about 3V of noise onto its mains cable, roughly 60dB more than the limits in EN 55013. Its high levels of emissions were spread from about 150kHz to 5MHz.

Often, when you find this problem with an older item of equipment, it is because the X and Y capacitors in its mains filter have finally succumbed to high levels of surges. These types of capacitors are designed to fail open-circuit, so as not to cause electric shock or fire hazards, and normal mains voltages are routinely exposed to surge voltages of 6kV (or higher, according to EN 50160), whilst the surge levels tested by immunity test standards listed under the EMC Directive are no more than 2kV, so failure of X and Y capacitors, resulting in increased levels of emissions, is not unusual. However, the X capacitors in this TV were checked and found they were fully functional.

The TV was a reputable make and it seems fairly certain that that model complied with the emissions limits in EN 55013 when tested. Having emissions that worsened by 60dB over 6 years of operation sounds as if it should be unusual, but BT have recently been saying that they are having significant numbers of similar problems with domestic appliances interfering with their broadband systems (see No. 515 above).

(Summary of a discussion with an EMC lab manager in the UK, who wishes to remain anonymous, 13th December 2007.)

517) Vacuum cleaner interferes with burglar alarm system

I have just disposed of an Oreck upright vacuum cleaner which we were given, as every time I used it, it set off the internal alarm on our burglar alarm system which could only be turned off by a full power down reset by the engineer. Normal keyboard reset codes had no effect. The burglar alarm system is pre-EMC Directive, being around 15 years old. It was cheaper to buy a new vacuum cleaner than replace the alarm system. I certainly wasn't going to pull up all the floorboards to harden the system.

It is worth pointing out that the burglar alarm system in question works quite happily with all my other appliances including heavy duty power tools, washing machines, washing up machines, Wi-Fi, Bluetooth, wireless phones and multiple mobile phones but then I assume the Oreck was CE marked in the US?

(Kindly sent in by Dr Nigel Carter, until recently Technical Manager E and EMC, QinetiQ, Farnborough.)

518) Justification for FAA rulemaking on High Intensity Radiated Fields (HIRF)

The electromagnetic HIRF environment exists because of the transmission of electromagnetic energy from radar, radio, and television transmitters, and other ground-based, shipborne, or airborne radio frequency (RF) transmitters. In the late 1970s, designs for civil aircraft were first proposed that included flight-critical electronic controls, electronic displays, and electronic engine controls, such as those used in military aircraft since the mid-1970s. Accidents and incidents on civil aircraft with flight-critical electrical and electronic systems have brought attention to the need to provide HIRF protection for these critical systems.

On April 15, 1990, an Airship Industries Airship-600 traversed the beam of a highly directional RF broadcast from a Voice of America antenna and suffered a complete loss of power in both engines that resulted in a collision with trees and the terrain during a forced landing in North Carolina. The National Transportation Safety Board stated in its investigation of the accident that the lack of HIRF certification standards for airships at the time of the airship's certification was a factor in the accident.

More recently, on March 2, 1999, a Robinson R–44 helicopter passed within 1,000 meters of the main beam of a high frequency (HF), high energy broadcast transmission antenna in Portugal. The pilot reported strong interference in the intercommunication and communication systems and navigation radios, followed by illumination of the low rotor revolutions per minute (RPM) and clutch lights. He further noted the engine noise dropped to idle level and the engine and rotor RPM indicators dropped. The pilot entered autorotation and landed the helicopter successfully with only damage to the main rotors. Following landing, the pilot reported all cockpit indications were normal. The accident investigation division of Portugal's Instituto Nacional da Aviação Civil stated in its investigation of the incident that the probable cause was severe electromagnetic and RF interference.

The FAA has issued three airworthiness directives (ADs) in response to HIRF effects between 1991 and 1998. In AD 91-03-05, Airship Industries Skyship Model 600 Airships, the FAA required the installation of a modified ignition control unit because of the previously described dual-engine failure that occurred when the ignition control units were exposed to HIRF.

In AD 96-21-13, LITEF GmbH Attitude and Heading System Reference (AHRS) Unit Model LCR–92, LCR-92S, and LCR-92H, the FAA stated there are indications of an unusual AHRS reaction to certain RF signals that could cause the AHRS to give misleading roll and pitch information. As a result, the FAA required either (1) the installation of a placard adjacent to each primary attitude indicator stating that flight is limited to day visual flight rules (VFR) operations only, or, if the primary attitude instruments have been deactivated, stating flight is limited to VFR operations only, or (2) a modification and inspection of the AHRS wiring cables, a repetitive inspection of the cable shielding, and an insertion of a statement in the aircraft flight manual regarding unannounced heading errors that could occur after switching from DC to MAG or operation of the ± switch in flight with any bank angle.

In AD 98-24-05, HOAC–Austria Model DV–20 Katana Airplanes, the FAA required the replacement of engine electronic modules to prevent electromagnetic interference in the engine electronic module. The FAA required the replacement of the modules because electromagnetic interference could cause the airplane's engine to stop due to an interruption in the ignition system resulting in loss of control.

Concern for the protection of electrical and electronic systems in aircraft has increased substantially in recent years because of—

(1) A greater dependence on electrical and electronic systems performing functions required for the continued safe flight and landing of the aircraft;

(2) The reduced electromagnetic shielding afforded by some composite materials used in aircraft designs;

(3) The increase in susceptibility of electrical and electronic systems to HIRF because of increased data bus or processor operating speeds, higher density integrated circuits and cards, and greater sensitivities of electronic equipment;

(4) Expanded frequency usage, especially above 1 gigahertz (GHz);

(5) The increased severity of the HIRF environment because of an increase in the number and power of RF transmitters; and

(6) The adverse effects experienced by some aircraft when exposed to HIRF.

*(This is the justification given for the FAA's 2006 HIRF rule for civil aerospace: "*FAA Action: High-Intensity Radiated Fields (HIRF) Protection for Aircraft Electrical and Electronic Systems – Docket No. FAA-2006-23658: Proposed rulemaking (NPRM), Advisory Circular 20-158, and Final rule.*". Note that for the previous 20 years there were special conditions in force to ensure aircraft were designed to resist the HIRF environment.)*

519) Another example showing that EMI is not a new concern

In the early 1960s NATO decided to start a missile test range in the Aegean sea. Genistron, a Southern Californian EMC testing and filter manufacturing company, was contracted to perform an RF survey of the area. The NATO folks were rightfully concerned about supersonic missiles heading in the wrong direction due to RF interference.

(Extracted from "Chapter Chatter" by Todd Robinson, a column in the IEEE EMC Society's quarterly newsletter, http://www.ewh.ieee.org/soc/emcs/acstrial/newsletters.htm, Issue 219, Fall 2008, page 12.)

520) Headphone magnets interfere with heart implants

Heart patients who have been fitted with pacemakers or defibrillators have been warned against placing the headphones of the MP3 players in their top pockets or draping them over their hearts. According to research presented at the American Heart Association's Scientific Sessions 2008, many headphones contain the magnetic substance neodymium, which could adversely affect the operation of cardiac implants.

Doctors use magnets in a clinical setting to test pacemakers, which treat slow heart rhythms. When exposed to magnets, these devices automatically pace, sending low energy signals to the heart to make it beat. Defibrillators, which treat slow and dangerously fast heart rhythms, send either low or high-energy signals to the heart, but when near magnets may stop looking for abnormal heart rhythms.

Implanted cardiac devices that react in these ways to magnets outside the clinical setting can be potentially dangerous for patients who rely on their lifesaving technologies. Field strength (sic) of 10 gauss at the site of the pacemaker or defibrillator has the potential to interact with the device. The researchers found that some of the headphones had field strengths as high a 200 gauss or more. "Even at those high levels, we did not observe any interactions when the headphones were at least 3cm from the skin's surface."

(Extracted from "Headphones interfere with heart implants", by Kris Sangani, Engineering & Technology, www.theiet.org/engtechmag, 22 Nov – 5 Dec 2008, page 6. This research, combined with the current fashionability of MP3 players, created numerous news items to be published in various media, including: http://www.interferencetechnology.com/lead-news/article/headphones-mayinterfere-with-implantable-defibrillatorspacemakers.html?tx_ttnews%5BbackPid%5D=1&cHash=59fcd739b9, www. t e l e g r a p h . c o . u k / h e a l t h /article3411300.ec. Many people brought it to our attention – thanks to you all! It is a useful reminder that EMC is not simply a radio-frequency issue, it is required down to DC.)

521) Digital TV interference from motorcycles

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

(This question was posed by a reader in "The last word" column in the New Scientist, www.newscientist.com/lastword, 25 Oct 2008, page 85. Rather than copy the three replies in full, the below is a brief summary of them.)

a) Modern cars use electronic ignition with lossy carbon cables, whereas two-stroke motorcycles and scooters use magneto-ignition with metal cables and so emit much higher levels of EMI.

b) Digital TV uses a very high level of coding, making the results of EMI worse than with analogue TV. Sometimes using double or triple-screened aerial cables can help.

c) Until analogue TV transmissions are switched off in the UK in 2012, digital TV is transmitted at low power. After 2012 the situation should improve.

(The third respondent mentioned that watching digital satellite TV he still suffered interference from one particular motorcycle, even though these TV signals are in the GHz range. This item also reminded the editor of staying in a UK hotel in 2008, watching digital TV while a farmer applied a petrol-powered hedge trimmer to his border about 30m away. When the trimmer was revved up to perform a cut, the TV picture would freeze until the farmer let the revs drop to an idle again.

522) New York Blackout caused by harmonics

The last major blackout in New York (NY, USA) was caused by harmonics and resulted in the creation of a series of standards and guidelines designed to guarantee network quality, even in the star-shaped mains distribution networks commonly used in the US (due to the large distances to be bridged.)

(Extracted from: "Beat the harmonics and clean up your power", Panel and System Building, www.psbonthenet.net/enquiries, October 2008, pages 14-17. And to think that President Bill Clinton once wrote to the EU asking them not to list EN 61000-3-2 in the Official Journal under the EMC Directive!)

523) Qantas QF72 plunge

The Singapore to Perth Qantas Airbus A330-300, which had 303 passengers, went into an uncontrolled climb and sharp descent on Tuesday as it neared the West Australia Coast. The scare resulted in injuries to 74 people, with 51 being treated by three Perth hospitals for fractures, lacerations and suspected spinal injuries after being thrown against the roof, walls and cabin furniture.

The crew called a mayday and landed at Learmouth airport, where the plane remains.

Chris Zombolas, the Technical Director of EMC Technologies, which tests electromagnetic fields made by electronic equipment, said the risks of passengers using laptops and other devices in planes was a serious issue. "It is well known in the electrical engineering community that the operation of electronics systems, including air navigation systems, may be adversely affects by electromagnetic interference, " he said. "Could a laptop or mobile phone have caused Qantas QF72 to plunge? The answer is yes," he said.

(Extracted from: "Laptop plane plunge query in Qantas case", Herald Sun, www.news.com.au/heraldsun/story/0,21985,24473201-661,00.html, 10thOctober 2008. This is another story on which a lot has been published in the media, and many people have sent it in to the Banana Skins column. Possible causes such as laptops and mobile phones have been investigated (although, of course, no-one with any assets to lose would admit to have been using such devices, when asked after the event), as well as the plane's proximity to a 1MW VLF (19.8kHz) submarine communications transmitter at Exmouth, Western Australia – which has been implicated by some in a similar malfunction in a Boeing 777-200 on 1ST August 2005. The latest news at the time of writing is that air transport investigators are saying that the incident was caused by a faulty computer component that sent "erratic and erroneous information" to the plane's flight control system. But I don't know at this time if they have actually found a faulty component, or whether they are simply assuming it must be faulty because erratic and erroneous data was received from it, which could of course be due to EMI (see the article: "Absence of proof is not proof of absence" in the EMC Journal, www.theemcjournal.com, September 2008, Page 16.))

524) Cell phone EMI warning

RF signals may affect improperly installed or inadequately shielded electronic systems in motor vehicles such as electronic fuel injection systems, electronic anti-skid (antilock) braking systems, electronic speed control systems, and air bag systems. For more information, check with the manufacturer, or its representative, of your vehicle or any equipment that has been added.

(Taken from the Nokia 6300 Cell Phone User's Guide 2008, kindly sent in by independent forensic engineer Dr Antony Anderson, antony.anderson@onyxnet.co.uk. It is important to understand that similar warnings are, or should be, provided by all cellphone manufacturers for all their models – the RF transmissions from the Nokia 6300 featured above are no worse than other cellphones in their ability to cause interference.)

525) Cellphone causes bus to change gear

NHTSA Identification Number: 06E-100

Date of Notification: 12-29-06

Model or Size Designation: Gear Shift

Identification of Component: Arens AS Tronic

Number of Components Recalled: 2,197

Brief Description of Defect: Mfg.Campaign No. N/A - Electronic Gear Shift.

DOM: N/A.

Electronic gear shifters, p/nos. 0501 214 599 and 0501 212 979 installed on transit buses. Cell phone placed in proximity of shifter touch pad could cause display to change from "R" (reverse) to "D" (drive) should phone receive call. Radio interference can also cause unintended shift. This will allow vehicle to move in unintended direction, resulting in crash. Correct by providing warning sticker and modifying software to prevent shift.

(Taken from a recall notice issued by the USA's National Highway Traffic Administration Authority (NHTSA), kindly supplied by Clarence Ditlow, Executive Director, Center for Auto Safety, 1825 Connecticut Ave NW, Washington DC 20009, www.autosafety.org, in December 2008.)

526) 12 metres of coal is not a good shield against EMI

SAFETY ALERT NO. 124, Issued 22/02/2005 by Mines Inspectorate, Safety and Health, Brisbane – Head Office, PO Box 2454 Brisbane QLD 4001, Australia, Phone +61 07 3237 1105 Fax: +61 07 3224 7768 Vision: 'Our Industries Free of Safety and Health Incidents'

Incident With 2 Remote Control Transmitters

MINE TYPE: All Underground Mines

INCIDENT: A twin heading underground roadway was being developed using two mining machines, (continuous miners), both controlled by their operators using hand held remote control transmitters. Each

continuous miner remote control operated on a different frequency to prevent interference between the 2 units.

A 10 to 12 metre coal barrier remained between the two development headings, (A&B), when the B heading miner was pulled back to the intersection on dayshift in readiness to recommence driving on afternoon shift.

At the start of afternoon shift the A heading remote control transmitter was mistakenly taken to B heading miner. When the operator tried to start B heading miner, the machine did not commence the pre-start cycle, however the A heading operator witnessed the A heading continuous miner commence its pre-start cycle. The operator alerted the panel deputy, who carried out additional testing and found he could start the miner in A heading from B heading.

EQUIPMENT: Equipment involved consisted of the two continuous miners and their respective hand-held remote control transmitters. The remote control transmitters were painted differently to match their respective continuous miners.

HAZARD: Uncontrolled operation of equipment

CAUSE: There were insufficient controls in place to prevent a remote control transmitter being mistakenly taken to the wrong mining machine, and then used to inadvertently commence the pre-start cycle on another machine in a separate development heading.

COMMENTS: Although the incident could not be repeated consistently, investigation established radio waves could travel through a coal barrier up to 12 metres thick.

Therefore the distance separating remote control systems underground cannot be relied upon as the only control measure to prevent interference between units. Beside the signal being able to penetrate the ground for some distance, there is always the possibility of the signal being coupled through cabling, pipework or metal roof supporting structures.

RECOMMENDATIONS: This hazard must be recognised, and the possibility of unintended remote control operation of machinery through use of the wrong transmitter, through the ground or over what at first appears to be long distances, must be considered in the development of a coal mine's safety and health management system, and in the risk management practices and procedures used by metalliferous mines.

Peter Garland, Regional Inspector of Mines – Southern.

Contact: John Kabel, Senior Electrical Inspector of Mines, +61 (07) 3237 1105

(Kindly sent in by Chris Zombolas of EMC Technologies Pty Ltd, www.emctech.com.au, 8th January 2009, http://www.nrm.qld.gov.au/mines/inspectorate/safety_alerts.html. The Banana Skins issue is that the mining industry – at least in Queensland – relies upon shielding by the earth to prevent radio controllers from operating the wrong machinery – yet in this case even 12 metres of (conductive!) coal did not provide sufficient attenuation. Who would have expected that?)

527) German Tornado crashes

Holzkirchen was the location of one of the main transmitting stations for Radio Free Europe. Transmissions started in 1951 and provided the people of Eastern Europe with news from Western Europe. The transmitters had a strength of up to 250 kiloWatts, and in the 1980s caused a Tornado aircraft to crash near Oberlaindern. Transmissions were reduced after the fall of the Communist block and the transmitters were dismantled in 2004.

UK Tornados never suffered from such interference, despite being exactly the same design and build, because pilots were issued with maps showing areas of high field strength from such transmitters, to be avoided during flight.

(From a presentation by Professor Nigel Carter, at the EMCIA meeting, held at the EEF in London on the 17 December 2008. Some of the information above is taken from http://en.wikipedia.org/wiki/Holzkirchen)

528) Microwave cooker interferes with TV

A neighbour told me he had recently purchased an 'own brand' LCD television from a well-known UK-wide chain of supermarkets, and installed it the kitchen of his house. It worked fine, except when the microwave cooker was operating, when its picture went totally crazy. A replacement from the same supermarket did exactly the same. After getting a full refund, he bought a well-known brand of LCD television instead, and this worked just fine in the same location.

(Mike Ashton, proprietor of Brocton Post Office, Brocton, Stafford, UK, in conversation with Keith Armstrong on 21 February 2009.)

(*Editor's note:* microwave cookers operate around 2.45GHz, and since this is not a frequency reserved for communications, the only limits at that frequency are based on human health hazards. But the immunity standard for televisions, EN 55020, does not test at frequencies above 0.15GHz. This is an example of how products that fully comply with EMC standards listed under the EMC Directive, can nevertheless interfere with each other in normal use and therefore fail to comply with the Essential Requirements of the EMC Directive – its basic legal requirements. Article 10 of 2004/108/EC exists for just such situations, but seems to be rarely invoked.)

529) DECT phone interferes with TV

I bought a well-known brand of LCD television, and placed it on a shelf in my living room. It would not work unless I pulled it about 6 inches forward, away from the wall. There was nothing I could imagine in the wall that might cause a proximity problem, yet the effect was repeatable. In case it was some kind of fault in the television, I swapped it for another one of the same type, which behaved just the same!

So next I suspected my rooftop antenna and its cable, and had them replaced. This new TV was becoming quite costly! But the new one had exactly the same problem!

Then, while trying to peer into the gap between the television and the wall to see if there was something odd going on in there (without much hope of success, but you have to try everything when the usual things fail), I pushed my wireless (DECT) telephone charger out of the way to get a better view. Suddenly, the television worked!

My telephone charger was also the basestation for the DECT system, and is apparently always transmitting. All that I had to do was move the 'phone 3 inches to one side, further from the television, and I had no more problems.

(From Phil Cross, of Sellafield Ltd (used to be BNFL), in conversation with Keith Armstrong on 23 February 2009.)

(*Editor's note:* DECT wireless telephones transmit about 0.25W at around 1.9GHz, and are licensed to do this. But just as for No. 528 above, the immunity standard for televisions only tests up to 0.15GHz, so once again products can fully comply with EMC Directive standards yet interfere in normal use. It is quite obvious that, these days, a domestic TV could be used near to a DECT phone basestation, or microwave cooker, yet the EMC standards do not cover such obvious situations.)

530) Weight-saving on military aircraft causes costly EMC problems

The Airbus A380 saves a lot of weight by using large areas of glass-fibre with a thin aluminium layer in its construction. However, the A400 military transport plane currently in development uses carbon-fibre panels instead, which are stronger and lighter, and also conductive. They do not have an aluminium layer.

Unfortunately, the carbon-fibre is not conductive enough to provide sufficient EMI shielding – so the project is suffering huge delays as filtering and shielding is added for the benefit of the on-board electronics. One wonders if the added weight of these EMI measures might offset the benefit of using costly carbon-fibre.

I would have imagined that, on a large project like this, using a new material that is well-known to have much lower conductivity than the traditional aluminium, and with the military's long history of costly EMC problems and resulting in-house expertise – that simple, quick, low-cost experiments would have been done to discover what EMI shielding would be achieved by using carbon fibre, and that they would have predicted this problem before the aircraft design even started.

(From Keith Armstrong, following discussions with attendees at an EMC training course in March 2009.)

531) Cost-saving on military aircraft causes costly EMC problems for suppliers

There appears to be a tendency to attempt to reduce the cost of new aircraft, which in some cases is creating great difficulties for suppliers of flight instruments. For example, some new helicopters have removed the EMI shielding layers from their glass cockpits, making the EM environment of the flight instruments almost the same as equipment mounted outside the vehicle, requiring them to function correctly (many of them flight-critical, some safety-critical) in radiated fields of kV/m at frequencies to 10s of GHz, to cover the situation where the helicopter is operating close to an airfield or carrier radar.

Since modern aircraft use one or more large LCD flat-panel visual displays, instead of large numbers of small 'dials', shielding these displays against kV/m fields requires a lot of metal in front of the screen, reducing its readability and dimming its brightness. Since the displays also have to be readable in bright sunlight, the power required by their backlights has to increase considerably, increasing the problems of dissipating heat in the flight deck.

(From Keith Armstrong, following discussions with attendees at an EMC training course in March 2009.)

532) A "Bermuda Triangle" in New York

Since Bermuda is too far away and the affected area is actually circular, we will name this phenomenon the "Manhattan Circle". Thus anointed, the psychic reach of the Manhattan Circle is centred on the Empire State Building and extends for about five city blocks. Airplanes and ships are not dealt with here for they are virtually nonexistent, save for a few exceptions like those of 9/11 and the aircraft that attacked King Kong.

Yet, within this circle some automobiles are doomed. Their remote keyless entry systems will not always work. Even if the mysterious force fails to deny an owner entry to his vehicle, it may disable his vehicle's ignition system, and assistance must be summoned. If towed five city blocks away, all systems are again GO!

As in the real Bermuda Triangle, only a few vehicles succumb. I. Leview, manager of Citywide Towing, asserts that 10 to 15 cars a day require his assistance.

At least no lives are lost and the force destroys no human hardware.

The phantom culprit apparently resides in the Empire State Building. Its grasping tentacles are only electromagnetic. Somehow, it seems, the many new antennas installed high atop this edifice after the demise of the twin towers of the World Trade Center have created a circular focus of electronic frustration.

(Richard Weir, "What's Making Cars near Landmark Go Kaput?" New York Daily News, January 27, 2008. Cr. M. Piechota, from William Corliss' book, "Scientific Anomalies", see http://en.wikipedia.org/wiki/William_R._Corliss, kindly sent in By Anne Silk.)

533) Cellphone turns on CD player

Garage door-openers often fall victim to electronic gremlins sent by nearby transmitter towers. When our granddaughter Stefi visits us, her cellphone repeatedly turns on our CD Player.

Repent, there's no escape from the coming Electronic Armageddon.

(A comment appended to the publication of No. 532, kindly sent in by Anne Silk.)

534) A poetic EMI experience

As Anne sat in her Volvo 'tank'
At Berko, somewhere near the bank
The traffic lights, they were so slow
To change to green they would not go.
But what was this? A 'clunk', a 'hiss',
Poor Anne's locked in, something's remiss!
Fear not, the Police are just right by
Their great antenna. Showing on high
Atop their Station, slowly swaying
Sent message down to Anne's car, saying
"Ho! Lock her in that Volvo there,
and watch her have a damn great swear"
Driving along towards Drumnessie,
Poor Anne was worried, what a messie!
The doors did open, all was well,
That RFI can go to hell!

(Personal communication from Anne Silk, to whom this happened on 15 February 2001. 'Berko' is local slang for Berkhamstead in the UK.)

535) EMC War Stories from Milton Kant

I'll go back pretty much to the beginning of my career in EMC which was at the Sperry Gyroscope Company. In those years, Sperry was an equipment manufacturer that made all types of equipment from complete airborne systems to airborne systems including control systems for drones. They made navigation systems for aircrafts; they made ground equipment; they made high powered radar for ground systems and ship-boards; and they made submarine equipment. They were the subcontractor for the Polaris submarine navigation system so our RFI lab started out as a measurement facility.

Once you start making EMC/RFI measurements, you end up also helping to fix any problems that you uncover for the equipment that is out of specification. You end up learning how to filter EMI, suppress emissions, and shield equipment. This lab/troubleshooting experience led in turn to trying to educate the design engineers that they should design the EMI suppression and shielding requirements into their equipment as part of the equipment design.

We used to hold classes for design engineers to try to teach them the basics of EMI design. Not only was it important to do the design correctly but it was also economical. To try to fix a piece of equipment after it's been designed and in pre-production equipment, built and gone through tests - to try to change the design after that effort is much more expensive than the effort that is taken during the design to make sure that you analyze the equipment and put the fixes in at the beginning. Most of the design and circuit engineers at Sperry would only be interested in getting the equipment to work in terms of performance characteristics. The requirements for interference, reliability and all the other environmental regulations were usually just an afterthought. That attitude was prevalent throughout the industry.

The Aegis system had a computer, which at that time was still a tube-computer because it used electronic tubes. They were using a clock bus in the megahertz range, two to four megahertz, around it. That bus was running around all the equipment. Naturally, when they tried to meet the EMC spec, the signal was radiating all over the place. A good effort was made to try to contain clock frequencies within the computers and not let them radiate. Once again, the designers weren't interested in that. They just knew they needed the clock frequencies to be sent all around their system and how to use them in operation of the computer.

We were building high powered radars which were being sited across the country as part of the early warning system. There was a site out at Mantioch, Long Island. They were getting complaints that they were picking up the radar on the radio and hi-fi systems out there. A second site in Michigan was interfering with a control tower at an airport nearby. We would go out and check the radiated characteristics of the signal to make sure that it met the requirements or that the harmonic levels were low. We made field measurements to validate that they were within the allowable limits. Then, we had to convince people that it's not the problem of the transmitter, rather, the design of the audio equipment was such that it was susceptible to these high-powered radars which supposedly indicated that no equipment was tested for susceptibility characteristics, especially commercial equipment. This is being remedied these days; I think there is much more awareness of the fact that all of the new electronic equipment is susceptible to high-powered radiation.

The Aegis Destroyer not only had EMC requirements, it had very high-powered radar. It was a challenge to make sure all of the other systems on the ship could operate when the radar was operating.

(Extracts from "EMC War Stories, by Milton Kant, EMC Society Founder, IEEE EMC Society Newsletter, Fall 2008, pp32-33, www.ieee.org/organizations/pubs/newsletters/emcs/fall08/history.pdf.)

536) Coronal Mass Ejection – inevitable Armageddon for the developed world

It is midnight on 22 September 2012 and the skies above Manhattan are filled with a flickering curtain of colourful light. Few New Yorkers have seen the aurora this far south but their fascination is short-lived. Within a few seconds, electric bulbs dim and flicker, then become unusually bright for a fleeting moment. Then all the lights in the state go out. Within 90 seconds, the entire eastern half of the US is without power.

A year later and millions of Americans are dead and the nation's infrastructure lies in tatters. The World Bank declares America a developing nation. Europe, Scandinavia, China and Japan are also struggling to recover from the same fateful event - a violent storm, 150 million kilometres away on the surface of the sun.

Surely the sun couldn't create so profound a disaster on Earth. Yet an extraordinary report funded by NASA and issued by the US National Academy of Sciences (NAS) in January this year claims it could do just that.

Our modern way of life, with its reliance on technology, has unwittingly exposed us to an extraordinary danger: plasma balls spewed from the surface of the sun could wipe out our power grids, with catastrophic consequences.

The projections of just how catastrophic make chilling reading. "We're moving closer and closer to the edge of a possible disaster," says Daniel Baker, a space weather expert based at the University of Colorado in Boulder, and chair of the NAS committee responsible for the report.

The surface of the sun is a roiling mass of plasma - charged high-energy particles - some of which escape the surface and travel through space as the solar wind. From time to time, that wind carries a billion-tonne glob of plasma, a fireball known as a coronal mass ejection (see "When hell comes to Earth" below). If one should hit the Earth's magnetic shield, the result could be truly devastating.

The incursion of the plasma into our atmosphere causes rapid changes in the configuration of Earth's magnetic field which, in turn, induce currents in the long wires of the power grids. The grids were not built to handle direct current. The greatest danger is at the step-up and step-down transformers used to convert power from its transport voltage to domestically useful voltage. The increased DC current creates strong magnetic fields that saturate a transformer's magnetic core. The result is runaway current in the transformer's copper wiring, which rapidly heats up and melts. This is exactly what happened in the Canadian province of Quebec in March 1989, and six million people spent 9 hours without electricity. But things could get much, much worse than that.

.....the grid's interdependence with the systems that support our lives: water and sewage treatment, supermarket delivery infrastructures, power station controls, financial markets and many others all rely on electricity.

.....it is clear that a repeat of the Carrington event (*1859, stunning auroras even at equatorial latitudes*) could produce a catastrophe the likes of which the world has never seen.

According to the NAS report, the impact of what it terms a "severe geomagnetic storm scenario" could be as high as $2 trillion. And that's just the first year after the storm. The NAS puts the recovery time at four to 10 years. It is questionable whether the US would ever bounce back.

"I don't think the NAS report is scaremongering," says Mike Hapgood, who chairs the European Space Agency's space weather team. Green agrees. "Scientists are conservative by nature and this group is really thoughtful," he says. "This is a fair and balanced report." Neither is Europe sufficiently prepared. Responsibility for dealing with space weather issues is "very fragmented" in Europe, says Hapgood. Europe's electricity grids are highly interconnected and extremely vulnerable to cascading failures.

When Hell comes to Earth

Severe space weather events often coincide with the appearance of sunspots, which are indicators of particularly intense magnetic fields at the sun's surface.

The chaotic motion of charged particles in the upper atmosphere of the sun creates magnetic fields that writhe, twist and turn, and occasionally snap and reconfigure themselves in what is known as a "reconnection". These reconnection events are violent, and can fling out billions of tonness of plasma in a "coronal mass ejection" (CME).

If flung towards the Earth, the plasma ball will accelerate as it travels through space and its intense magnetic field will soon interact with the planet's magnetic field, the magnetosphere. Several things can then happen. If the fields are oriented in the same direction, they slip round one another. In the worst case scenario, though, when the field of a particularly energetic CME opposes the Earth's field, things get much more dramatic. "The Earth can't cope with the plasma," says James Green, head of NASA's planetary division. "The CME just opens up the magnetosphere like a can-opener, and matter squirts in."

The sun's activity waxes and wanes every 11 years or so, with the appearance of sunspots following the same cycle. At the moment the sun appears calm. "We're in the equivalent of an idyllic summer's day. The sun is quiet and benign, the quietest it has been for 100 years," says Mike Hapgood, who chairs the European Space Agency's space weather team, "but it could turn the other way." The next solar maximum is expected in 2012.

*(Extracted from "*Gone in 90 Seconds*" by Michael Brooks, New Scientist, 21 March 2009, pp 31-35, www.newscientist.com. The report mentioned is: "*Severe Space Weather Events--Understanding Societal and Economic Impacts: A workshop report*", http://www.nap.edu/catalog.php?record_id=12507.)*

*(Other recent articles on this subject include "*The 2012 Apocalypse — And How to Stop It*" by Brandon Keim, Wired Science, 17 April 2009, http://www.wired.com/wiredscience/2009/04/2012storms/, and "*2012: The Year Of Looming Solar Disaster, When Civilization Devolves?*" by Brian Dipert, EDN, 5 May 2009, http://www.edn.com/blog/400000040/post/1810044181.html?nid=3351&rid=9249788.)*

(The Editor writes: Banana Skin No. 448 discussed a US Congressional report, available from: http://www.empcommission.org/docs/A2473-EMP_Commission-7MB.pdf, that described how a single airburst nuclear bomb would knock the USA – or any developed nation – back into the iron age, with huge numbers of deaths and complete breakdown of civil society, simply because of the damage it would do to the HV distribution transformers on which – it turns out – almost every aspect of our lives relies if we live in a developed country.)

(Nobody keeps spare HV transformers, and they take at least a year to manufacture <u>if all the necessary services are readily available</u> – which they won't be if the HV grid is down. And how do you start up a power plant with no grid power available? Where are you going to find the 100MW you need to jump-start your 400MW generator?)

(We could at least believe that we could prevent an airburst nuclear explosion over our country, whether this belief was justified or not, But there is no way to stop a coronal mass ejection like the 1859 Carrington Event, which would destroy most HV grids around the world, could happen tomorrow, and is <u>certain</u> to occur one day.)

537) EMC Trends and Needs

The main building blocks of an electronic system are the integrated circuits (ICs). According to the International Technology Roadmap for Semiconductors, the communication speed between the chips is increasing and is projected to be 10 GHz with an on-chip clock of 15 GHz in the year 2010.

Given this projection, logic thresholds will be lower, the noise margin will decrease, and ICs will become more vulnerable to interference. Radiated emissions will increase because of faster switching edges and the concomitant increase in energy in a harmonic spectrum that extends to higher frequencies.

Over the coming decade, the number and variety of potential disturbance sources and victims is set to increase exponentially—leading to an astronomical increase in the risk of interference. Consequently, controlling this interference is becoming a key issue in system design.

The market needs safe, secure, highly reliable, low-cost products that are interference-free and EMC-compliant. To achieve this goal, new methods and tools must be developed to reduce emissions and to boost the immunity of components, interconnects, and subsystems. The future electromagnetic environment must be controlled by legislation and standardization with new test methods, frequency bands, and limits.

EMC Design

A high-speed digital lifestyle (including digital radio/TV, Internet, and new applications and services) is fast emerging. By 2010 all products will incorporate digital technology. Multimedia products combine radio, TV, PC, and wireless functions. Such device integration only increases the risk of self-pollution. The explosive growth in the popularity of wireless devices will lead to greater interference challenges. In-home digital wired and wireless networks will cause non-traditional EMI scenarios.

Time-to-market and product life cycles are becoming increasingly shorter. For consumer electronics, the first six months on the market are the most profitable. If the product launch is delayed, a significant share of the life-cycle profits may be lost. EMI problems can thwart speedy movement along the critical path of product creation. The risk of re-design must be reduced, and design efficiency must be improved. Better design methodologies are needed to reduce emissions and to increase immunity. Possibilities include simulation/diagnostic tools, new design rules, and expert systems in CAD tools.

An integral EMC design approach is needed to achieve an optimum cost-effective integration of technologies at the chip, package, board, cable, module, enclosure, and system level. Signal integrity (SI) thermal, software, and cost must be factored into any effective approach.

EMC Standardization

Crucial areas for improvement include:

More and stricter EMC regulations must be developed for products with high clock frequencies, for digital modulation techniques, and for wired and wireless communication devices. An increase in the number of microprocessors in homes, businesses, factories, and vehicles will lead to a rise in interference problems. New emission and immunity test methods must be developed for higher frequencies (mode-stirred chambers, fully anechoic rooms, etc.)

Reassessment of present EMI limits is warranted given the changes taking place in the electrical environment. EMC practitioners must develop a database of defined protection levels for radio services that can be used as a basis for deriving future EMC limits.

Digital radio services have tolerances to broadband and narrowband interference that differ from those of analog services. There is an urgent need to investigate the impact of these differences when determining interference limits and test methods for digital radio/TV products. Resolving the digital EMC problem will be a major challenge in the coming decade.

The EMC of networks and installations constitute the "missing link" in the current mass of EMC standards. Many wired home networks use existing power or telephone wiring and—without coordination—such an arrangement will lead to EMC problems.

EM Safety

Product safety issues must be addressed. All electronic devices are subject to errors or malfunctions caused by electromagnetic interference. A functional safety perspective on EMC is needed in those cases in which errors could result in injury or harm to the health of users. Failure to do so puts consumers in jeopardy and leaves manufacturers exposed to financial risks including liability lawsuits, product recalls, negative publicity, and loss of consumer confidence. In fact, the risks caused by EMI-related functional safety lapses are increasing because of:

- Rapidly increasing use of electronics in safety-related applications,
- Worsening electromagnetic environment,
- Increasing use of electronic devices.

At the present time no published safety or EMC standards adequately control EMI-related functional safety issues.

(Extracts from: "Towards an EMC Technology Roadmap", by Marcel Van Doorn, Technology & Strategy Manager of the Philips Electromagnetics & Cooling Competence Center, http://www.interferencetechnology.com/articles/articles/article/towards-an-emc-technology-roadmap.html. The brochure: "Vision 2020:The EMC Technology Roadmap" may be downloaded from www.emc-esd.nl, link:ETN-SEE.)

538) Interference: Reports from the Field

This Banana Skin Item is a compendium very kindly sent in by Pete Alsop, a Senior Field Engineer working for Ofcom (www.ofcom.org.uk). Ofcom has the responsibility for radio, TV, radiocommunications and telecommunications (including the Internet) in the UK, and part of that is ensuring that these services do not suffer from interference, so they employ 35 field engineers whose job it is to investigate complaints and deal with them. Causing the interference to cease is a matter of pride to them, and they deal with most complaints successfully.

If you think you might have an interference problem with your telephone (landline or cell), your radio or TV reception, or your internet service, click on "How to complain" on the above website, or go direct to http://www.ofcom.org.uk/complain/.

I had asked Pete what technologies gave him and his fellow field engineers most interference complaints over the years. I was not concerned with co-channel or adjacent-channel interference, or illegal transmitters, all of which Ofcom's field engineers also have to deal with, and his reply (on 30 June 2009) is below.

Here is a general breakdown of types of proven causes of interference for the period January 2007 to May 2009:

Lighting Systems	*252*
Thermostats	*223*
Aerial Amplifiers	*197*

Power supplies (switch-mode)	*82*
Digital Receivers	*49*
IT equipment	*33*
Motor Systems	*29*
Ignition Systems	*24*
ISM Equipment	*5*
Welding Equipment	*1*

You can see from above, that the two major causes of interference, and several others, are wide band interferers, where obviously some kind of arcing is taking place. The cause of the arcing is obvious enough in a thermostat, and explains why we find that complaints of interference increase during the winter months – more people are using their central heating, and so are passing currents through the contacts of the thermostats on their boilers and in their rooms!

PLT is a new technology that Ofcom are also receiving complaints about, and solving, but it is felt that it is too early to include it on the above list of interference from established technologies. The latest Ofcom update on PLT is at: www.ofcom.org.uk/radiocomms/ifi/enforcement/plt.

I once had to deal with a complaint of radio interference that turned out to be caused by a low-power nightlight that used a low-energy fluorescent tube. At certain times, it would apparently start to arc inside, causing the problem. Filament lightbulbs will also often maintain a small arc inside (usually before they fail) that can generate a surprising amount of radio noise.

Aerial amplifiers have become less of a problem more recently, as Digital Terrestrial Television broadcasts using OFDM techniques can cope well with a single carrier interferer. Cheap unfiltered aerial amplifiers are also prone to creating intermodulation products (overloaded by strong RF signals nearby) which go on to interfere with the required TV channel, and that's why they are high on the list.

Generally speaking, our work results from devices that have been incorrectly installed and/or have developed a fault of some description, not as a result of being poorly designed with regards to EMC.

Occasionally we do have issues with equipment radiating energy on or very close to the emissions limit in an EN standard. For example, recently I received a complaint from an airport that used 125MHz for AM voice communications, complaining of a permanent interfering signal at a particular location. The source was traced to a nearby building which had recently installed a new CAT 5 cabled IP CCTV security system, where its external video cameras were radiating 125MHz from clock circuits within the control switch, which was located deep in the centre of the building. The cameras where changed for others, and this stopped the interference. But it was not really the cameras' fault – they weren't generating the interference themselves, simply allowing it to pass through.

Here are some examples and experiences that my colleagues and I have had over the years.

- Light sensors found radiating in the TV band causing patterning to one UHF channel. The light sensors where submitted for testing under the relevant EMC Directive-listed standards, which showed that they failed to satisfy both the radiated emission *and* interference power limits.

  The devices contained an emission source having a 10 MHz bandwidth with the maximum emission occurring at the top of the band at 157 MHz. The disturbance power emission (EN 55014) limit was exceeded at 157 MHz by 37.8 dB. Radiated emissions exceeded the limit (EN 55022 Class B) at 157 MHz by 31.4 dB and exceeded the limit at 314 MHz and 471 MHz by 23.8 dB and 8.7 dB respectively.

  The manufacturer claimed compliance with EN 55014, but this standard applies specifically to household appliances, electric tools and similar apparatus. This standard only tests up to 300 MHz, so does not encompass the TV band in which its 471 MHz (the third harmonic of 157MHz) emissions spectrum lies. Tests were made using EN 55022 (information technology equipment) which is the basic measurement standard applicable to residential, domestic and light industrial applications, which covers up to 1000 MHz and so covers all of the UHF television bands. This standard was considered to be more applicable to light sensor devices.

- Complaints were received from numerous residents unable to start their vehicles due to spurious carrier blocking the RF receivers on the key fob car alarm/management systems.

  The signal was traced to a child's life size motorbike with a built in video game operating on the 433 MHz licensed exempt band. The residents couldn't believe it until we de- activated the gaming unit on the bike adjacent to the affected vehicles and the problem cleared. The RF unit had developed a fault and was returned to the manufacturer by its owner.

- In the 1970s I was still dismantling old sewing machines and vacuum cleaners to fit suppression capacitors. Central heating interference was solved by trying suppressors first and only condemning the worn-out thermostat if all else failed to stop the interference. There was still VHF monochrome television susceptible to all forms of electrical interference and herringbone patterning from transmitter harmonics and local oscillators in other receivers. Valve oscillators ran at higher power levels than today's semiconductors and shielding had to be restricted to allow for their cooling.
- 4 watt AM CB Radio appeared in the late 1970s and early 1980s, revealing terrible EMC design weakness in every type of electronic appliance, including telephones. In the worst cases, the breakthrough would continue with the affected TV set or HiFi amplifier switched off and unplugged. The audio output transistors or ICs would act as 'crystal set detectors' and produce sufficient energy to drive the loudspeaker audibly *without any additional power*.
- Microwave ovens appeared in the 1980s, revealing EMC weakness in nearby TV tuners, which accepted the low levels of 2.4GHz from the ovens. On certain channels, a harmonic of the TV local oscillator would fall at the I.F. frequency away from the microwave oscillation, resulting in a distinctive pattern on the TV screen whenever the cooker was in use.
- Vehicle ignition suppression has improved but some misguided car enthusiasts still compromise the vehicle's EMC performance by replacing carbon plug leads with copper, resulting in TV interference where reception is weak. A few white analogue dots can be ignored but DTTV is far less forgiving with pixilation and sound loss causing greater annoyance.
- Manufacturers of electric motors and thermostats gradually incorporated RF components into the design, but occasionally the suppression fails, or a fault generates excessive interference.
- TV aerial amplifier design used to be straightforward and cheap – high gain, no shielding, no filtering and wide bandwidth. Amplifier specifications are now far more important – with cellphones below 1GHz, Airwave communications (e.g. TETRA), Amateur, CB and PMR on many other frequencies. Dynamic range is also more critical with five analogue channels and six weaker DTTV multiplexes having to be amplified without excessive intermodulation. Also, when a mast head amplifier develops a fault, it easily becomes an oscillator and causes nearby interference.
- Rear-of-set TV amplifiers continue to create problems. A favourite is the unused amplifier which remains powered. The owner, not fully understanding it finds a loose coax flex and plugs it neatly into a spare socket. It looks tidy but an oscillator has now been created causing interference to nearby TV or radio.
- Low-power radio devices operating in the license-exempt 433MHz band are used for a wide variety of purposes, but inevitably a small number develop a fault and transmit constantly causing interference.
- For example, cordless doorbells operate around 433 MHz, as do car remote door locks. A manufacturer designed a doorbell push with a grey rubber button surrounded by a white plastic housing, but if its button is pressed slightly off-centre it gets trapped under the plastic surround – causing the doorbell to transmit permanently. A nearby car's door lock receiver cannot receive the brief signal from the key fob (being swamped by the continuous noise from the door bell) so the car stays locked.
- Although ADSL broadband causes little radio interference, plug-top switch-mode power supply units that power their wireless routers only have a manufacturer's expected MTBF of 3 to 4 years when run 24/7 as many people do. One PSU fault which occurs generates high levels of wideband buzzing across MF and HF radio frequencies. Ironically the noise is easily induced into unshielded telephone wiring, considerably slowing ADSL speed for the owner of the faulty unit and also neighbours nearby.
- I guess interference affecting TV reception has changed with the uptake of DTV. What used to be a tolerable interference problem, e.g. an occasional one second burst from an arcing boiler thermostat affecting analogue TV has now become more of a problem. The one second burst now appears as a total loss of reception for a longer period of time, due to the processing time of the digital receiver.
- One that I have quoted as an example of the 'never discount anything' principle, involved domestic TV interference that went in bursts. Each burst lasted 2 - 3 minutes at a time and the

first one would be around 7.30pm. This was followed by another at around 8.00pm with a third shortly afterwards. It would then be quiet all evening until around 11.00pm where there would be two further bursts.

- The source was traced to a house on the opposite side of the road occupied by a family with three youngish children. The source was found to be a battery operated toothbrush and the bursts coincided with bedtime for the children followed by bedtime for the parents!
- You wouldn't think that something running off a single 1.5V battery could have caused interference that was strong enough to affect a television the best part of 100m away – but these toothbrushes did!
- Electric fences have caused a few problems particularly if they are poorly maintained. DIY repairs to the long wire result in arching and play havoc with DTTV reception, whereas previously – with analogue TVs – only a faint horizontal line may have been seen.

539) Cellphone turns on gas oven (with link to YouTube video)

Ever have that sinking feeling that you left a major appliance running when you left the house? Well you might not be paranoid: It may actually be on... though not of your own doing.

Andrei Melnikov found that out the hard way: Something activated his oven, causing it to turn itself on and melt a plastic meat thermometer which had been left inside.

How did this happen? Melnikov and his Brooklyn apartment building's skeptical super eventually figured it out through trial and error: The tenant's ringing cell phone somehow turned on his nearby Maytag oven when it rang. If you're skeptical, check out the video of this in action at the New York Times website and see for yourself.

Calling the situation "highly unusual," Maytag (and other experts) blame the problem on electromagnetic interference -- basically the same thing that happens when your cell phone gets too close to your speakers and it starts making that beep-beep-beeping noise. In this case, the interference didn't make a sound but rather caused the oven to turn on.

And this may not be an isolated incident: The Times suggests that preliminary experiments have confirmed that different brands of cell phones can activate multiple models of Maytag ovens. And, as the story notes, the oven "prefers high" and activates the broiler when it turns on -- which means anything inside the thing is going to get totally fried. On the other hand, tests with a General Electric oven failed to generate the same response.

Takeaways? It's hard to be a Luddite these days, but mysterious situations like this are likely to become more and more common as advanced electronics find their way into an increasing number of products. There's no special reason why an oven or a toaster needs to have a computer brain so advanced, but microprocessors have become so cheap it's probably easier to include one in an oven than it is to include an old-fashioned, analog temperature control system... and it's probably more accurate, too.

The bottom line: Always keep an eye out for oddball effects like this. If you see something strange happening with the electronics in your kitchen -- or any other room in the house -- consider how close your cell phone is when the antics occur, and try a little home-grown experimentation for yourself. Hey, maybe you'll make the news.

(Copied from: "It ain't poltergeists: Cell phone activates oven", Mon Aug 24, 2009 12:25AM EDT, visit: http://tech.yahoo.com/blogs/null/147548. ***For the YouTube video****, visit: "Hello, Oven? It's Phone. Now Let's Get Cooking!" by Jim Dwyer, The New York Times, August 23, 2009, http://www.nytimes.com/2009/08/23/nyregion/23about.html?_r=2.*

It also appeared on Fox News as "Cell Phone Call Lights Man's Gas Oven", Monday, 17 Aug 2009, 10:02 AM EDT, http://www.myfoxdc.com/dpp/news/offbeat/Cell_Phone_Call_Lights_Mans_Gas_Oven_dpgo_20090817_jst_2992357; and by Sonia Rincon as "A Brooklyn Man's Kitchen Surprise", 1010 WINS, Monday, 17 August 2009 7:12PM, http://www.1010wins.com/A-B-klyn-Man-s-Kitchen-Surprise/5016882.

Kindly sent in by Dennis Swanson, Electromagnetic Effects Staff Engineer - Specialty Engineering Group, Lockheed Martin MS2 Tactical Systems, Eagan, Minnesota; Dr William Radasky, President, Metatech Corporation, Goleta, California; and Paul Bertalan of Sensis Corporation, Dewitt, New York State. Banana Skins certainly gets around! The photograph above is of the cooker model concerned, the Maytag Magic Chef, model CGR1425 ADW.)

(On 8th October 2009, just after the publication of this Issue in September 2009, Richard Babyak, the Editor of Appliance Design magazine sent me a link to a CBS News item on this story, which has ***a much better video*** *than the one mentioned above! Visit: http://www.cbsnews.com/stories/2009/08/18/national/main5248949.shtml)*

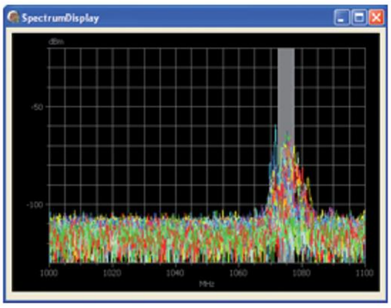
540) Mysterious Signal in Cumbrian Village

Ofcom, the UK agency charged with achieving the most efficient use of the spectrum, commissioned a study which mapped the use of spectrum throughout the UK. Several anomalies turned up in it.

Just north of Cambridge, high powered transmissions can be detected in the 863- to 870-MHz band that is ostensibly for the use of short-range devices such as remote light switches and car key fobs.

Another surprise was a mysterious signal at 1.075-GHz coming from the Cumbrian village of Millom.

Figure 57 Spectral data plot for 1.075 GHz, Millom village centre



The mystery was soon solved without any need for the investigative wiles of a Sherlock Holmes.

The signal was tracked to a small shopkeeper operating an illegally imported closed circuit TV setup.

The entire report on spectrum mapping can be viewed at: http://www.ofcom.org.uk/research/technology/research/state_use/vehicles/vehicles.pdf

(Copied from http://www.interferencetechnology.com/lead-news/article/mysterious-signal-in-cumbrian-village.html, 05/13/09 02:50 PM, kindly sent in by Ged Dean, of Nottingham University Hospitals NHS Trust.)

541) Interference causes recall of defibrillators

Medical device manufacturer Welch Allyn is recalling approximately 14,000 external defibrillators after 39 reported incidents, including two deaths. The recall involves 14,054 AED 10 and MRL "JumpStart" external defibrillators manufactured between October 3, 2002 and January 25, 2007. According to Welch Allyn there is the possibility that these prescription devices are susceptible to electromagnetic interference, may deliver low energy shock, or may shutdown unexpectedly. If these issues prevent defibrillation in a patient in cardiac arrest, the outcome would be fatal. For additional details, visit the Welch Allyn website www.welchallyn.com/support/customer/AED_lookup.jsp

(Copied from "Interference vs. Defibrillators", http://www.interferencetechnology.com/lead-news/article/interference-vs-defibrillators.html, 03/18/09 10:49 AM.)

542) People trapped in elevators

I did a survey on a lift installation last year, high rise building, processors playing up, people being trapped in elevators for long periods as the systems were crashing.

The problem was traced to the elevator mains riser earth being bonded onto the roof lightening conductor, but elevator's earth return was severed in the building, meaning that the elevator's earth return was the lightening conductor. Now consider 20 floors worth of landing push button stations being connected only to a lightning conductor!

This was not the only problem, and it took me a week to correct all the installation faults and get the elevators working reliably

(Kindly sent in by Gary Morgan, email, 5th March 2009)

543) EMI Cited as One Possible Factor in Deadly DC Metrorail Crash

The National Transportation Safety Board continues to make progress in its investigation of the June 22, 2009, collision of two Washington Metropolitan Area Transit Authority (WMATA) trains on the Red Line in Washington, D.C. The Board has developed the following factual information:

Two signal companies, Ansaldo STS USA (US&S) and Alstom Signaling Inc. (GRS), that designed and manufactured the automatic train control components for the WMATA system, are providing technical assistance to the NTSB investigation.

As previously reported, an impedance bond (#15) for the track circuit where the accident occurred was replaced on June 17th, 2009, five days before the accident. Continued review of the maintenance logs has identified that the impedance bond (#14), located on the other end of the same circuit, was replaced in December 2007. WMATA records reveal that this track circuit's train occupancy signal has been intermittently fluctuating since the replacement was installed in December 2007.

The NTSB has requested trouble tickets for the last 18 months to see if these problems had been reported, and seeking records to see if any operators reported problems on this circuit.

The investigation is identifying possible sources of interference affecting the automatic train control (ATC) operation. These potential sources include Electromagnetic Interference (EMI), traction power harmonics and signal crosstalk, communication lines, and system upgrades and changes.

Following the accident, WMATA began to review operations data and identified some problems at other circuits. These anomalies are being examined by NTSB and WMATA to determine if they are the same kinds of problems as were found in the location of the accident site.

Testing has identified that the circuit problems are occurring more frequently during the rush hour time period. As a result, the NTSB and WMATA testing at the accident location on the Red Line is continuing. These tests may result in occasional delays on the Red Line in the Fort Totten area. All testing in the Fort Totten area is closely coordinated with WMATA and is scheduled to minimize delays on that area of track during rush hour.

On Saturday, July 18, the NTSB conducted a sight distance test at the accident location. Information collected from the test will be correlated with rail markings documented after the accident, the braking characteristics of the striking train, and the speed information gleaned from the WMATA Operations Control Center records.

(NTSB Advisory, National Transportation Safety Board, Washington, DC 20594, July 23, 2009, THIRD UPDATE ON NTSB INVESTIGATION INTO COLLISION OF TWO METRORAIL TRAINS IN WASHINGTON, D.C., http://www.ntsb.gov/Pressrel/2009/090723.html. I was put onto this by Interference Technology, http://www.interferencetechnology.com/lead-news/article/emi-cited-as-one-possible-factor-in-deadly-dc-metrorail-crash.html)

544) CMOS latch-up causes aircraft safety problem

I am reminded of a verified war story about one of the first "Glass Cockpits" introduced in the Biz-Av world. An engineering safety analysis had determined that the likelihood of simultaneous failures of both the pilot's and co-pilot's primary attitude reference was less than one chance in a billion flight hours.

On the first take-off of the first test flight of the certification program, as the pilot rotated the aircraft off the runway both displays went to big red x's...both displays were inop. This problem was resolved to a hardware failure of a CMOS MUX chip that suffered from a condition known as latch-up.

(Kindly sent in by "John", who wishes to remain anonymous, by email on 17th July 2009. For more on the latch-up phenomenon, which afflicts most common types of ICs but has been especially problematic for CMOS types, visit: http://en.wikipedia.org/wiki/Latchup.)

545) From the archives — Mains spikes crash payroll computer on Fridays

This was told to me so long ago that I'm surprised it hasn't already appeared in Banana Skins!

Many years ago, when computers were just entering large corporations and were viewed suspiciously by people who didn't see what was wrong with the 'old ways', a company installed one of these new-fangled machines to handle the payroll.

Programs were written, test data run through the system and all went well until the system crashed whilst running the 'live' payroll data on a Friday morning.

More tests were run, and everything worked fine until the next Friday morning when another crash occurred.

After a couple more weeks of this, it was found that the 'old guard' had a room full of clerks double-checking the figures on their trusty electric adding machines every Friday morning. The resulting mass of mains spikes was too much for the computer power supply to handle...

One thing this taught me was to check for less obvious causes of problems – the "what else was happening when the unit failed?" type of question. Shredders on the same mains outlet seem to be a particular favourite!

(Kindly sent in by Andy Gulliver, email, 8th July 2009)

546) Singapore Grand Prix gearbox failure

And after their one-two in Monza a fortnight ago, this was a sobering session for Button and his Brawn team mate Rubens Barichello.

The Brazilian, who lies 14 points behind Button with four Grands Prix to go this year, had a golden opportunity to close the gap but a gearbox failure in practice, caused by electro-magnetic signals from the subway system beneath the Marina Bay Circuit, meant he entered qualifying knowing he would have a five-place grid penalty no matter what.

(Extracted from an article by Tom Cary in the Telegraph, 27 September 09, which was kindly sent in by Dave Imeson, Secretary of the EMC Test Labs Association, www.emctla.co.uk.)

547) "Smart" life raft beacons too dumb

Considerable progress has been made regarding the re-introduction of personal locator beacons (PLBs). Below is a summary of where we currently are in the process.

Background: Personal beacons, which were being carried by some passengers on offshore helicopter flights to oil and gas installations, were withdrawn from service in March, following the ditching of an offshore helicopter in the UK sector in February. It was found that interference from the personal beacon had caused the 'smart' long-range beacons on the life rafts to shut down.

The smart technology fitted to the life raft beacons is designed to shut the beacon down if it detects another beacon signal within a certain radius. This is to ensure that only one high-powered aircraft beacon is transmitting at a time, which helps search and rescue operations to home in more effectively and protects battery life. However, in the February ditching, the lower powered (non-smart) passenger PLBs were detected by the smart beacons, which caused life raft beacons to shut down. This could have had implications for search and rescue operations *(because the high-powered beacons shut down in favour of the lower-powered personal beacons, which would not be as easy to locate – Editor)*.

(From an email entitled: "Helicopter Task Group update – Re-introduction of Personal Locator Beacons – 04 November 2009", by the United Kingdom Offshore Oil and Gas Industry Association Limited, trading as Oil & Gas UK, kindly sent in by Simon Brown, Principal Specialist Inspector, HSE Hazardous Installations Directorate – Offshore Division. To find out more about the work of the helicopter task group and other important areas of work, please go to: www.oilandgasuk.co.uk/issues/helitaskgroup.cfm.)

(This item is not, strictly speaking, an EMI incident like those we normally report here. It is more of an operational incompatibility, but nevertheless it is important because we are making equipment 'smarter' all the time by using digital processing to run more software – but of course it is still very dumb indeed when compared with a person, not clever enough to deal with unforeseen problems like this example of 'interference'.)

548) Bad connection in 50kV line interferes with TV, cellphones, even cable TV

A bad connection in an overhead HV cable was producing S9+10dB on my receiver. On a quiet afternoon you could hear the acoustic noise from the arc 100 feet away! The power utility was initially uninterested until I threatened to complain to the FCC that their AC mains line fault was producing enough RF interference to make HF communication impossible. The work crew asked me to show them the location, and they sort of freaked out at the intensity. It was a 50KV line and at twilight the arc was clearly visible. As they were working, people who lived nearby stopped by to see what was happening. After the mechanical fault was repaired, the locals were very happy because they could watch TV and use their cell phones. The RF noise was intense enough to penetrate the cable TV system.

Given your professional interest in EMC and RF noise sources, I thought you might find the handbook "The Mitigation of Radio Noise from External Sources at Radio Receiving Sites, 6th Edition", published by the US Naval Post Graduate School, interesting and useful. It has been a great help in locating "local" power line noise sources. In a personal Email with George Munsch, he told me the companion "internal noise" handbook is about 90% complete, but the School lacks the funds for completion. www.arrl.org/tis/info/HTML/power_line_handbook/ExternalNoiseHandbook.pdf.

(Kindly sent in by Terrence Fugate, WN4ISX, 13 October 2009.)

549) Access BPL can seriously interfere with safety of flight

Before the Federal Communications Commission, Washington, DC 20554, In the Matter of Carrier Current Systems, including Broadband over Power Line Systems, ET Docket No. 03-104

Amendment of Part 15 regarding new requirements and measurement guidelines for Access Broadband over Power Line Systems, ET Docket No. 04-37

Reply Comments of Aeronautical Radio, Inc.

Aeronautical Radio, Inc. ("ARINC") hereby submits its Reply Comments in these proceedings. The record makes clear that access broadband over power line service ("Access BPL") can seriously interfere with the nation's high frequency communications system that guards the safety of flight and thus should be authorized only under conditions that protect the HF Aeronautical Mobile (R) Service.

(From: http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6516214698. Also see: http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6516214700, http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6516214699, and http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6516214701. Kindly sent in by Peter Kerry, EMC Consultant, 19 October 2009, who saw them on the UKQRM website www.ukqrm.org)

550) Boy's TV interfered with aircraft

A signal booster on the television set of a Bedfordshire boy has been found to be interfering with aircraft. The aerial on 12-year-old Nicky Chamberlain's bedroom TV was disrupting communications between pilots and air traffic control at Luton airport.

Communications regulator Ofcom traced the problem to the home in Knaves Hill, Linslade, 18 miles from the airport.

Nicky's dad, Dave Chamberlain said: "I came home to find an Ofcom engineer parked outside the house. It was bizarre. I had never heard of anything like this before. Nicky had the booster for a couple of years and there had been no problem. Recently they changed the flight-path and that must have caused the problem with pilots talking to the airport."

He added: "We are decorating Nicky's bedroom now and when that's finished we will get him a new aerial that does not interfere with passing planes."

A spokesperson for communications regulator Ofcom said: "It is not common for something like this to happen. We have field engineers who go around the country investigating for radio interference. In this case the faulty aerial booster was found to be interfering with the pilot's radio."

(Taken from BBC News: http://news.bbc.co.uk/go/pr/fr/-/1/hi/england/beds/bucks/herts/8327549.stm, 2009/10/27, kindly sent in by Peter Day, System/Development Engineer, Hitech Instruments Ltd, and by John Davies, Managing Director, Blackwood Compliance Laboratories, on 30 October 2009. Visit http://news.bbc.co.uk/1/hi/england/beds/bucks/herts/8327549.stm, which has a video.)

551) Detecting PC keyboard strokes by sniffing the ground

My mate John sent me this BBC news link just now, it's fun in case you hadn't seen it: http://news.bbc.co.uk/1/hi/technology/8147534.stm

A couple of lads have discovered they can pick up keystroke signals from PS/2 connections on the mains earth at a distance. The presentation to which it refers is here: http://dev.inversepath.com/download/tempest/tempest_2009.pdf

I'd thought the BBC report was a bit flaky on the description of the connection, and assumed it was a typical journalistic misquote, but actually the report quotes the presentation quite accurately. The authors themselves aren't really clued-up on EMC. It turns out that they are monitoring the noise voltage between the ring main earth and building metalwork, which has enough of the coupled PS/2 signal to give useable data when filtered.

Of course, TEMPEST as a subject has been around for years, but it's fun to see a couple of hackers (for this is what they are) getting into the public domain with it. I particularly like one of the points in the "Why bother?" slide of the presentation: "As always....more important: girls will melt when you show this..." And the Tempest acronym is decoded as "The Emissions Might Produce Extremely Sweet Talks"

(Kindly sent in by Tim Williams, EMC Consultant, Elmac Services Ltd, www.elmac.co.uk, in July 2009.)

552) Wireless headphones tune-in to Elvis

I bought a pair of wireless headphones a few years ago, I put them on in the shop and was surprised to find music come out of them. Not knowing what frequency they worked on, didn't think to much of it. Anyway it turns out that they run in the 863 to 870 MHz area and they are the auto tuning type so they regularly tune in to probably this broad cast. Someone who is probably at home all day, has it connected to their home stereo, and has a particular liking for amongst others Seasick Steve, Thin Lizzy and Elvis. Currently broadcasting Elvis.

(Kindly sent in 20th October 2009, the author wishes to remain anonymous.)

553) Tyre pressure warning triggered by Fort Meade

Click and Clack (Tom and Ray on NPR's [National Public Radio] Car Talk) had a caller this morning saying that her Vesta tire-pressure warning system goes off whenever she drove on a particular stretch of highway. After a little grilling, it turns out she was passing the NSA complex at Fort Meade. C&C concluded it had to be Radio Frequency Interference, and wondered whether it affects only Vestas, or perhaps other late-model cars with the newly mandated wireless sensors that might operate on the same frequency.

(Kindly sent in on 24th April 2009 by Matthew Wilson, Product Design & Production Manager, GB Electronics (UK) Ltd, who saw the above extract (Sun, 19 Apr 2009 11:06:45 PDT, From: "Peter G. Neumann" neumann@csl.sri.com, Subject: Vesta tire-pressure warnings) on the 'comp.risk' newsletter moderated by the 'ACM Committee on Computers and Public Policy', http://catless.ncl.ac.uk/Risks, and thought of the Banana Skin column.)

554) Scientists Map Earth's EM Emissions

An international team of scientists have issued a report on whistler-mode chorus waves, a type of electromagnetic emission generated by electrons in Earth's radiation belt, that have the potential to cause massive interference with satellite electronics as well as ground based communications.

The researchers used data from NASA's THEMIS (Time History of Events and Macroscale Interactions during Substorms) satellites to map the distribution of these waves.

They found that on Earth's nightside, chorus occurs only near the equator, but that daytime chorus extends to higher latitudes. Also, it appears that the amplitude of chorus waves depends strongly on geomagnetic activity.

At a distance greater than seven Earth radii (approximately 45,000 kilometres) moderate chorus is present more than 10 percent of the time and persists even during periods of low geomagnetic activity.

(Extracted from a report in Interference Technology magazine: http://www.interferencetechnology.com/lead-news/article/scientists-map-earths-em-emissions.html, 3rd June 2009. An abstract of the scientists' report is at: www.agu.org/pubs/crossref/2009/2009GL037595.shtml.)

555) Urban Wi-Fi Interference

British telecom regulator Ofcom has commissioned a report that concludes that Wi-Fi performance in central London can be up to four times slower than that found in less densely populated areas.

Although users of Wi-Fi have blamed nearby networks for much of the interference in the 2.4-GHz Wi-Fi band, the authors of the report pin the primary sources of interference on cautious parents using analog baby monitors, tired citizens watching retransmitted TV in their bedrooms, and microwave ovens.

The report notes that in central London, there are too many networks with resends, beacons, and housekeeping filling 90 percent of the data frames sent over Wi-Fi, thus leaving only 10 percent for users' data.

Another source of Wi-Fi trouble is caused by London's "Free Public Wi-Fi" points that are sending out beacon frames ten times more frequently than they should (every 0.01204 seconds) resulting in a significant amount of traffic on the Wi-Fi band.

Further complicating the situation is the fact that the makers of inexpensive unlicensed devices such as analog baby monitors or remote switches have no real incentive to develop more expensive digital models that cause less interference.

The entire 93-page report can be viewed online at: www.ofcom.org.uk/research/technology/research/exempt/wifi/wfiutilisation.pdf, "Estimating the utilisation of key license-exempt bands spectrum bands", Final Report, Issue 3, April 2009, for Ofcom by Mass Consultants Ltd, Cambridge, UK, systems@mass.co.uk, MC/SC0710/REP003/3, 149 pages

(Copied from a report by Interference Technology magazine, 05/13/09 02:57 PM: www.interferencetechnology.com/lead-news/article/urban-Wi-Fi-interference.html,)

*(Interestingly, on 17th May 2009 the Sunday Times reported on a proposed car safety system that relies on Wi-Fi and GPS technology. See "*Stop, Driver! The chip will take over now*", by Emma Smith in the Ingear section. Also see "*Technology could stop speeding and crashes*" at http://technology.timesonline.co.uk/tol/news/tech_and_web/article6294866.ece. Are the proposers of these systems* ***totally*** *mad? We have known since 2001 that GPS is not recommended for safety-*

*critical applications (see the very many items on EMI to GPS in "*The First 500 Banana Skins*" book, especially numbers* 222, 223,230, 231, 232, 238, 357, 363, 388 and 420 at www.theemcjournal.com or www.emcacademy.org/books.asp) *and now we learn that Wi-Fi is in big trouble too.)*

556) RF Interference to Broadband Internet from Christmas Lights

UK ISP PlusNet said: "When putting up the tree this year, don't forget that some Christmas tree lights (especially some flashing ones) can cause intermittent connection faults. So, if you think you've got a broadband fault please remember to turn your lights off for a while and see if that cures the problem before calling."

"Some tree lights generate RF interference which can affect broadband ADSL. It's best to keep your Christmas tree lights and wiring well away from your telephone cables."

"Some people have suggested that one way of detecting interference is to tune an analogue radio to Medium Wave 612 through to 693, which should buzz when you wave the radio near problematical tree lights. We've not tried this though and you may have more than one source (RF band) of interference."

It should be noted that we haven't seen many problems like this in recent years, thanks in part to the growing take-up of lower power LED lights and fibre optic trees. The issue mostly affected older lights.

(Taken from: "Annual UK ADSL Broadband ISP and Christmas Tree Lights Warning", MarkJ - 5 December, 2009 (9:00 AM), http://www.ispreview.co.uk/story/2009/12/05/annual-uk-adsl-broadband-isp-and-christmas-tree-lights-warning.html, also reported by Interference Technology magazine http://www.interferencetechnology.com/lead-news/article/rf-interference-from-holiday-lights.html, 12/09/09 05:18 PM.)

557) Reducing RF Interference to Broadband Internet

The iPlate is fitted to the home's master (NTE5) telephone socket simply by removing a couple of screws on the front plate, popping in the iPlate, then replacing the screws. This filters out the interference.

The Sunday Times has been testing two iPlates for several months. On one broadband line the speed has increased from just shy of 2Mbps to a far perkier 3.6Mbps – an improvement of 80%; on the other, speeds went from 3.5Mbps to 5.3Mbps, a 51% increase. Impressive stuff.

How does this miraculous little gadget work? Everything from microwave ovens to Christmas Tree Lights can affect home broadband and force the connection to drop out or run at a fraction of its potential. It's not only electrical equipment in your home that can affect your internet speed either: BT once bought a customer a spanking new television because his old set would bring down the entire street's broadband every time he switched on Top Gear.

All this interference is picked up by your home's bell wire, a copper cable that acts like an aerial. It is fitted to most homes, and originally was used to make old bakelight phones ring. Digital Phones have made this wire redundant but, like a human appendix, it still causes problems. The iPlate bypasses the bell wire, making broadband connections faster and more reliable.

Solwise says that the I-Plate, which BT claims can improve your broadband speed by up to 1.5Mbps when fitted to your home phone socket, isn't worth buying.

The I-Plate is a self-install filter which needs to be fitted in between the front and back plate of the BT NTE 5 master telephone socket. The I-Plate disables the bell wire that was used to make older telephones ring. Solwise, however, suggests a manual solution to disable the bell wire.

"The Solwise solution to this problem would be to detach the front section of your master socket and disconnect the bell-wire(s) (from pin 3) and re-fit the faceplate," the company said in an email.

A BT spokesman told Web User: "We couldn't comment on whether Solwise's instructions would be a successful alternative. The I-Plate has been fully tested and we know it gets results, and it's more convenient than fiddling about in the socket yourself." The spokesman also pointed out that the master socket belongs to BT and shouldn't be tampered with.

(Taken from: "The budget broadband booster" by Barry Collins, in the "ingear" section of the Sunday Times, 8 March 2009, and also from http://www.webuser.co.uk/news/top-stories/397999/don-t-buy-bt-i-plate-says-stockist, 1 Jan 2010. If you fancy trying Solwise's solution, visit http://www.thinkbroadband.com/faq/sections/radsl.html#235.)

558) High powered transmissions north of Cambridge

I have spotted a connection between Banana Skin No. 540 and the interference with my wireless headphones that was reported in No. 552.

No. 540 reported: “Just north of Cambridge, high powered transmissions can be detected in the 863- to 870-MHz band that is ostensibly for the use of short-range devices such as remote light switches and car key fobs”. My headphones operate over 863.5 to 864.5MHz, so it seems likely that these “high powered transmissions just north of Cambridge” are from the same Elvis fan that interferes with them.

(Kindly sent in by David Cleare, 15 December 2009)

559) Some pre-compliance testing ‘war stories’ from Laplace Instruments

In a message dated 18/11/2009 14:30:22 GMT Standard Time, tech@laplace.co.uk writes:

A manufacturer was considering the purchase of some in-house test kit, so they wanted a demo of our stuff. After the usual pre-amble, we set up to measure conducted emissions on a bench top ultra-sonic cleaning tank. This (I was assured) was a compliant unit.

Measurement quickly showed that the unit was definitely non-compliant. Harmonics of 68kHz were over the QP and Ave limits by up to 6dB in the 150 - 600KHz region. Confusion and consternation!

So another example of the same type was brought in. This was definitely a modified unit so should be OK. Result... even worse! Panic.

Obviously it was our Laplace equipment that was wrong... after all, who would question a test lab report?

Then the Actual Unit (the one that had actually been to the test lab) was brought in. Result.... OK, both QP and Ave below the limits by about 4dB (worst case). Hurray! But, all units were supposed to be the same?

On further investigation, both the non-compliant units had the transducer drive cable ty-wrapped to the incoming mains lead. Cutting the ty-wraps and making the two cables take different routes cleared the problem and reduced the emission levels to below the limits.

Conclusion...

1. If you have a sample tested as OK by a lab, you must ensure all other units of the same type are exactly the same.
2. The temptation to blame the test equipment for 'awkward' results should be resisted!

In a message dated 18/11/2009 17:50:02 GMT Standard Time, tech@laplace.co.uk writes:

We now have had a couple of instances of quite deliberate 'tweaking' of EMC results to obtain a 'pass', in both cases the guilty party was a 'foreign' test lab. In both cases Laplace equipment was used by the UK importer (Our customer) to check the compliance and in both cases we had a heluva job to convince our customer that 'we' were delivering the correct results. In both cases we chose (at our cost) to use the services of an independent accredited test lab in the UK to show that indeed our results were correct!

Our customers are inevitably impressed by official-looking certificates and accreditation marks, and will always assume such results are 'gold-plated'.

However, in each case, to the experienced EMC practitioner, they just looked wrong. They both were conducted emissions results, but they had a base line slope, conveniently angled such that relatively high peaks at one end or the other of the spectrum, were just below the limit. In one case the problem was at the low end, and the baseline sloped up with increasing frequency, and the other had a base line that sloped down, with 'problem' peaks at the high end. They both looked like they have been tweaked in Excel before plotting.

In a message dated 03/12/2009 17:38:43 GMT Standard Time, tech@laplace.co.uk writes:

Our Chinese distributor had a potential customer who was going to buy our kit. His product was a pulse mode PSU.

He had been to an accredited test lab and the PSU had failed – over the limit at around 24MHz. So he used that product as an evaluation test for our kit.

Our kit passed the product... no problem at 24MHz.

Naturally the customer was less than pleased, and our distributor was p....d off too!

We responded that our kit is always correct... so the test must have been done wrong. A certain amount of dialogue ensued after which they sent the PSU to me for further checking, expecting me to show that indeed it failed at 24MHz.

When we checked it in the office... no problem at 24MHz. We cycled this damn thing around 2 'proper' test labs, both gave results just like ours, no problems at 24MHz.

Looking at the Chinese results, they just looked like they had the 'poor LISN grounding' problem. We explained this phenomenon in great detail to them... but they were not interested and we never heard any more from them. I still have that PSU on my shelf!

(Extracts from three emails from David Mawdsley, MD of Laplace Instruments, to Keith Armstrong. David kindly agreed the above could be published as Banana Skins.)

560) RFeye helps in the fight against illegal use of the radio spectrum

Dr Alastair Massarrella, CRFS Cheif Executive, explained that the idea for RFeye originated from a previous point-to-multipoint radio telecommunication business, which was plagued by interference in licensed bands from sources such as air conditioning systems kicking in or less sophisticated telecoms equipment.

(Taken from “Frequency Finder” by Bernice Baker, The Engineer, 9-22 March 2009, page 11, wwwtheengineer.co.uk. RFeye is “A ruggedized box containing intelligent spectrum measuring equipment, small enough to fit into a backpack.”)

561) “Digital Dividend” will interfere with millions of TVs, and broadband

Introduction: The “Digital Dividend” refers to the reallocation of 790-862MHz band previously used for analogue TV broadcasting, which has become available due to the switch-over to digital TV. However, televisions and other devices that still have analogue TV tuners are very likely to suffer interference from the new applications proposed for his band.

There is now a TC210 WG which will start work early next year on a new standard, but it will not help the millions of installed devices that have analogue TV tuners.

Background: Since the changes in spectrum allocation resulting from the WRC decision of 2007 were announced (*i.e. the “digital dividend, see Figure 1, which contains other surprises too – for example the spectrum allocated to PLT – Editor*), the European Commission (EC) and the Electronic Communications’ Committee (ECC) have moved extremely quickly to consider: “The identification of common and minimal (least restrictive) Technical conditions for 790-862 MHz for the digital dividend in the European Union” (CEPT Report 30).

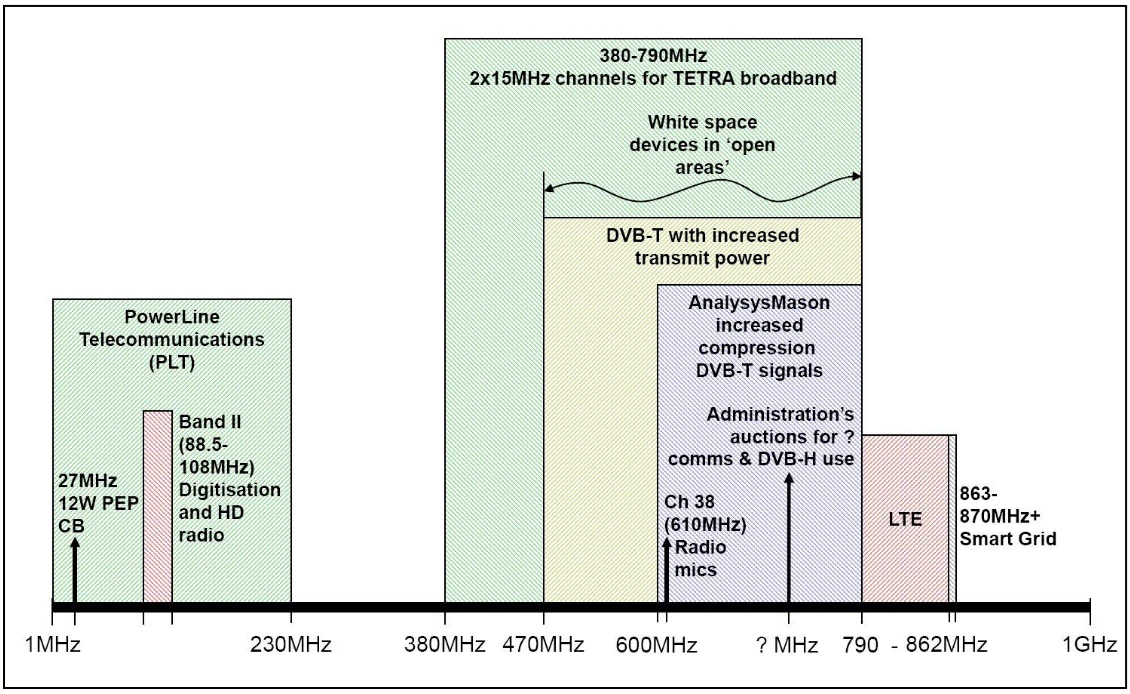


Figure 1: The Digital Dividend Spectrum (from Brian Copsey’s TC210 report)

However, whilst the plight of domestic television reception has received some attention (ECC report 138), during the ECC work on the EC mandate a number of arrears affecting domestic reception of television and use of broadband have not been considered at all. These are:

1. The wide variety of domestic (and professional) broadcast reception equipment using a “tuner”.
2. Immunity of equipment when a transmitter is used adjacent to it.
3. Citizens connected to communal aerial systems where a large complex of dwelling units is fed by a single aerial head end, these systems can also be found in University campus.

Many of these systems use broad band amplifiers with a very high gain both at the head end and also at floor or building level. Once a mobile signal, either base station or terminal unit operating within the frequency range of the amplifier is present interference or overloading of the communal system will take place giving interference or blocking TV reception by users of the system.

4. Cable TV networks which provide television, broadband and video on demand services to 74 million household, again the reception frequency of the set top box and the new mobile service (i.e. LTE) are the same and will cause interference or loss of service to the citizen.

The policy of “flexible use of spectrum” will also see further changes in the use of the 470-862MHz band at present under discussion (see Figure 1) by the EC and ECC will likely increase the interference potential to citizen’s use of broadband and television services in coming years. For example:

- Analysys Mason have recently (9 September) given a presentation of their findings which includes a proposal that higher compression ratios should be used in TV broadcasts which will allow the band from 600 – 862 MHz to be released for communication use.
- A range of other groups including the PPDR are attempting to obtain spectrum (2 x 15 MHz) in the 470-862MHz band using TETRA.
- A number of administration wish to clear additional TV channels to either auction off or reallocate, probable for mobile use, including mobile TV.
- “White space” devices are being developed for this band.

The Interference potential of the above:

To date, television “tuners” have only had to operate in a relatively benign band occupied by broadcast transmissions and services ancillary to program making (SAP) consisting mainly of radio microphones in unused channels.

In future they will be operating in a harsh electromagnetic environment and need to consider the techniques used by transceivers to provide interference-free reception to viewers.

Already the European Commission statements of 28 October say that receiver design must be reviewed.

A first set of measurements by the Netherlands Administration on the effect of proposed LTE cellphones showed that interference with cable television varied between 39% and 91%, depending on the LTE frequency of operation, and distance from the TV set and its set-top box.

(The above is a combination of extracts from a paper presented by Brian Copsey, and another paper by Mr Robijns, both provided to both IEC TC210/WG1 and TC210 on 3 December 2009, plus emails from Dave Imeson, all kindly provided by Dave Imeson, Secretary of the EMC Test Labs Association (www.emctla.co.uk). Dave Imeson also raised this issue at the meeting of the EMCIA on 15th December 2009.)

*(**LTE** (Long Term Evolution) is the project name of a new high performance air interface for cellular mobile communication systems. It is the last step toward the 4th generation (4G) of radio technologies designed to increase the capacity and speed of mobile telephone networks. Where the current generation of mobile telecommunication networks are collectively known as 3G (for "third generation"), LTE is marketed as 4G. However, it does not fully comply with the IMT Advanced 4G requirements. Most major mobile carriers in the United States and several worldwide carriers have announced plans to convert their networks to LTE beginning in 2009. See http://en.wikipedia.org/wiki/3GPP_Long_Term_Evolution for more detail.)*

562) New Porsche Panamera: EMI locks people inside

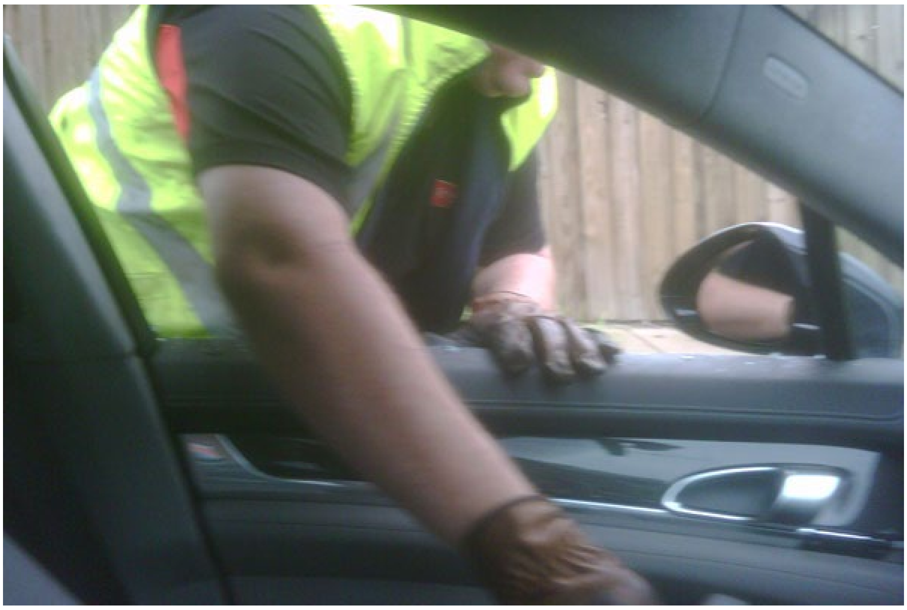
Recalls and service campaigns are often triggered by issues experienced by owners. The Drive team learnt that first-hand after spending a few days with the new Porsche Panamera.

After days of fault-free motoring, the Panamera's electronics were tripped up when it was parked in a semi-industrial area in Sydney's north.

Its sensor key was not recognised and getting any response from the car was almost impossible, even though the battery was fully charged.

After five minutes of trying to lock and unlock doors (in an effort to reset the system or immobiliser) a phone call was made to Porsche Assistance. It was then that the locks thunked closed — and refused to open. Three people were trapped — wife and child included. Door handles did not work, buttons did not respond and with no ventilation the cabin heated up quickly.

After half an hour — including a phone call to the police — the decision was made to smash a window. *(See photograph below, Editor)*



It took another 90 minutes to drag the car on the tow truck, with its electronic handbrake refusing to release. (See photograph below, Editor)

Porsche has since tracked the problem to radio interference, presumably from TV and radio towers in the area. Similar problems had apparently occurred in four other Panameras around the world, although this was the first time people were trapped in a car.

Porsche subsequently tried a software update but it failed. More recently the company ordered a radio suppressor unit designed by the factory in Germany to further shield the electronics from interference; it was trialled this week and worked.

Porsche now intends to fit the suppressor units to all Panameras as part of a mandatory service campaign.

While Porsche has stopped short of a recall, it has contacted Panamera customers (the car has only been on sale a few months so there are only about 50 on the road) and informed them of an imminent fix.

"It's a very serious matter given that we had people locked inside the car and we have reacted as quickly as possible and have found a solution which involves the fitment of a radio suppressor unit," says Porsche Australia public relations manager Paul Ellis.

Ellis says service campaigns are common among all brands and are often completed at regular services; the owner may not even be aware.

"This is obviously a phenomenon and is in no way a reflection on inferior build quality of the Panamera. External interference is not something that can be completely eliminated and you do get black holes where interference is possible. It's just unfortunate that this event transpired the way it did."

*(Braham Bloom of EMI Solutions spotted an article on this, written by Toby Hagon, on page 7 of the "Weekend Drive" section of his local paper, the Sydney Morning Herald (Weekend Edition Feb 27-28 2010), and very kindly sent it to me. Chris Zombolas of EMC Technology Pty Ltd saw a shorter version of the same article, also by Toby Hagon, in his weekend paper, The Age, dated 27 February. http://theage.drive.com.au/motor-news/road-test-throws-up-a-realworld-drama-20100226-p84l.html, which referenced the Sydney Morning Herald as its source. The article copied above is the one from The Age, because I could not find a weblink to the original article and didn't want to have to type it all out by hand. Chris Z also wrote: "*North Sydney is where the TV broadcast transmitters are located. (they have hundreds of other lower power transmitters as well). We have measured 3-6 V/m in the area surrounding the towers but that was a few years ago before digital transmissions commenced. Absolute and undeniable evidence of unforeseen problems caused by low level common interference sources.*")*

563) Mystery of the 'Windermere triangle' solved

A mystery phenomenon that has left motorists in a popular tourist town unable to unlock their cars has been solved.

For around 18 months, drivers parking up in one of the Lake District town's busiest shopping areas have found their electric key-fobs will not work.

Telecom watchdog OFCOM decided to investigate and sent field engineer Dave Thornber to Windermere with specialist scanning equipment.

He discovered that motorists' key fobs were being jammed because they were on the same wireless frequency as the till in the nearby Lazy Daisy Lakeland Kitchen cafe.

Mr Thornber said: "People thought it was a spook or some newly installed traffic lights but it is the till and the way waiting-on staff input meal orders."

He added: "We used what is called a spectrum analyser to make a sweep of the locality."

"The source of the interference was a wireless order taker in the cafe."

"The device used the same frequency as modern car key fobs which operate central locking."

"The key fobs use a very low power source to protect the life of the batteries inside and so their use was drowned out by the power of Lazy Daisy."

Some car owners complained that when they tried to open their cars they activated electric windows instead, others simply got no response at all. Motoring organisations were called in and batteries replaced but to no avail.

Cafe owner Tom Benton said: "Working with OFCOM we have adjusted the till frequency so it does not jam the locks anymore."

Mr Benton added: "I am just glad the whole mystery of the Windermere Triangle has been solved and there will not more people standing around their cars unable to drive off." "People have been talking about it for months."

(Sent in by Matthew Wilson, Product Design & Production Manager, GB Electronics (UK) Ltd., www.gbelectronics.com/ who saw this in his Daily Telegraph newspaper on Friday 26th February, see: www.telegraph.co.uk/news/uknews/7325141/Mystery-of-Windermere-triangle-solved.html. Also sent in by Claire Ashman, Assessment Manage of UKAS (United Kingdom Accreditation Service), who found a similar article on the BBC News, 2nd March 2010 at: http://news.bbc.co.uk/go/pr/fr/-/1/hi/england/cumbria/8545104.stm. The Daily Telegraph had previously carried a story on this: "Drivers mystified by secret of 'Windermere Triangle'" on 12th Feb 2010, see: http://www.telegraph.co.uk/motoring/news/7215551/Drivers-mystified-by-secret-of-Windermere-Triangle.html. This was of course before Ofcom's intrepid ghostbuster Dave Thornber had arrived on

the scene, sirens wailing, fearlessly doing battle with weirdness armed only with what the BBC said was "a sophisticated gadget called a spectrum analyser" (much to Claire's amusement!).)

564) Some recent NASA Aviation Safety Reports

ACN: 754696 (5 of 50): Synopsis: In an apparent PED interference event, a PAX's portable Garmin GPS Model NUVI 660 allegedly interfered with a B7373 Classic's (no glass) DME Navigation update function.

(PED stands for passenger electronic device, a PAX is a passenger, PAX is multiple passengers, and DME stands for Distance Measuring Equipment, a type of radar fitted to aircraft – Editor)

ACN: 702630 (13 of 50) Synopsis: Captain of an A320 reports VHF interference on ZOB ARTCC frequency from a cellphone aboard his plane.

ACN: 681689 (15 of 50) Synopsis: A B757-200'S L fuel gauge blanked after takeoff and became operable prior to landing. Crew suspects possible PED interference.

ACN: 673795 (16 of 50) Synopsis: B737-800 flight crew experienced several TCAS RAs allegedly generated by a Wi-Fi enabled laptop computer.

(TCAS is the Traffic alert and Collision Avoidance System, designed to reduce the incidence of mid-air collisions between aircraft. An RA is a Resolution Advisory message generated by the TCAS when it detects a potential problem. See: http://en.wikipedia.org/wiki/Traffic_Collision_Avoidance_System)

ACN: 661013 (17 of 50) Synopsis: Flight crew of CRJ-700 reports that aural interference in VHF communications ceased when PAX were asked to ensure all forms of 2-way communications were turned off.

ACN: 609264 (26 of 50) Synopsis: B737-300 crew had erratic LOC signals on ILS runway 13 and runway 7 at JAX. A PAX was using a 'Palm Pilot' at the time.

(ILS is Instrument Landing System, see: http://en.wikipedia.org/wiki/Instrument_landing_system)

ACN: 600964 (29 of 50) Synopsis: Flight crew of MD80 experience misaligned heading info on FMS display. Suspect PAX operated electronic devices.

(FMS is the Flight Management System and controls navigation, see http://en.wikipedia.org/wiki/Flight_management_system)

ACN: 597486 (31 of 50) Synopsis: A false TCASII RA sends a DC9 flight into a climb to avoid a potential target 5 miles south-east of BUNTS International, NTXN, PA. A flight attendant had caught a lady trying to call her daughter on her cellphone at the time the flight "pulled up".

(TCASII is a version of TCAS, Traffic alert and Collision Avoidance System, see earlier)

ACN: 579608 (35 of 50) Synopsis: DC-9 Flight crew received a false TCAS RA during departure climb and increased their rate of climb to avoid a false target apparently generated by a PAX laptop computer.

ACN: 576709 (36 of 50) Synopsis: A B737-700 crew, on approach to BWI runway 10, attributes being off course to possible unauthorized use of cellphones prompted by a cabin announcement. The inability of the crew to both be on the ILS frequency because of the approach design, also may be a contributing factor.

ACN: 576147 (37 of 50) Synopsis: MD88 crew has static on the #1 VHF communications radio. The static stopped when the PAX were directed to turn off their electronic devices.

ACN: 535960 (47 of 50) Synopsis: CL65 crew had a possible PAX originated RF Interference with an autoflight system during vectors of the approach.

ACN: 533786 (50 of 50) Synopsis: B727 FLC experienced erratic VOR NAV course indicator possibly due to PAX use of an electronic device.

(VOR means VHF Omni-directional radio Range, a type of radio navigation system for aircraft, see http://en.wikipedia.org/wiki/VHF_omnidirectional_range.)

(The above are all synopses taken from the July 29, 2009 update to the NASA ASRS Report, http://asrs.arc.nasa.gov/docs/rpsts/ped.pdf, downloaded 17 February 2010. The full reports are available in the same download. I don't know where earlier "updates" are archived, or even if they are archived at all, but I have copies of all the ones that have been referenced in earlier Banana Skins if anyone needs them - Editor.).

565) **Solar Storms Could Be Earth's Next Katrina**

Photo by Bob Martinson/AP

The northern lights dance over the Knik River near Palmer, Alaska. Activity on the surface of the sun creates this natural light show, but severe solar storms could devastate Earth's power and water utilities, and knock out communications.

Government officials are concerned that a massive solar storm could leave millions of people around the world without electricity, running water, or phone service, according to a report by National Public Radio. The impact is likely to be far worse than in previous solar storms because of the growing dependence on satellites and other electronic devices that are vulnerable to electromagnetic radiation.

Solar Storms Could Be Earth's Next Katrina *by Jon Hamilton, February 26, 2010*

A massive solar storm could leave millions of people around the world without electricity, running water, or phone service, government officials say.

That was their conclusion after participating in a tabletop exercise that looked at what might happen today if the Earth were struck by a solar storm as intense as the huge storms that occurred in 1921 and 1859.

Solar storms happen when an eruption or explosion on the surface of the sun sends radiation or electrically charged particles toward Earth. Minor storms are common and can light up the Earth's Northern skies and interfere with radio signals.

Every few decades, though, the sun experiences a particularly large storm. These can release as much energy as 1 billion hydrogen bombs.

How Well Can We Weather The Solar Storm?

The exercise, held in Boulder, Colorado, was intended to investigate "what we think could be close to a worst-case scenario," says Tom Bogdan, who directs the Space Weather Prediction Center in Boulder. The Center is a part of the National Oceanic and Atmospheric Administration.

"It's important to understand that, along with other types of natural hazards, (solar) storms can cause impacts," says Craig Fugate, Administrator of the Federal Emergency Management Agency (FEMA), who also took part in the tabletop exercise.

Bogdan and Fugate say that eventually there will be another storm as big as the ones in 1921 and 1859 — a sort of solar Katrina.

But the impact is likely to be far worse than in previous solar storms because of our growing dependence on satellites and other electronic devices that are vulnerable to electromagnetic radiation.

In the tabletop exercise, the first sign of trouble came when radiation began disrupting radio signals and GPS devices, Bogdan says.

Ten or 20 minutes later electrically charged particles "basically took out" most of the commercial satellites that transmit telephone conversations, TV shows and huge amounts of data we depend on in our daily lives, Bogdan says.

"When you go into a gas station and put your credit card in and get some gas," he says, "that's a satellite transaction."

Disabled Satellites Are Just The Beginning

The worst damage came nearly a day later, when the solar storm began to induce electrical currents in high voltage power lines. The currents were strong enough to destroy transformers around the globe," Bogdan says, leaving millions of people in northern latitudes without power.

Without electricity, many people also lost running water, heat, air conditioning and phone service. And places like hospitals had to rely on emergency generators with fuel for only two or three days, Bogdan says.

In many ways, the impact of a major solar storm resembles that of a hurricane or an earthquake, says Fugate.

But a solar Katrina would cause damage in a much larger area than any natural disaster, Fugate says. For example, power could be knocked out almost simultaneously in countries from Sweden to Canada and the U.S., he says. So a lot more people in a lot more places would need help.

Individuals don't need to make any special preparation for a solar storm, Fugate says. The standard emergency kit of water and food and first aid supplies will work just fine.

"If you've got your family disaster plan together, you've taken the steps, whether it be a space storm, whether it be a system failure, whether it be another natural hazard that knocks the power out," Fugate says.

(Copied from www.interferencetechnology.com/lead-news/article/solar-storms-could-be-earths-next-katrina.html, 3rd March 2010, and www.npr.org/templates/story/story.php?storyId=124125001&ft=1&f=1001)

566) Severe lightning in Kentucky

Recently there were several severe storms in Kentucky. A real nasty one that produced an abnormal amount of intense lighting passed about 20 miles south of us.

www.wkyt.com/news/headlines/82320257.html is a link to TV news coverage, which is only about half accurate about the damage: "A single lightning strike from a thunderstorm damaged three homes in Boyle county Thursday night. The homes are located on Lebanon Road. The lightning bolt left a trench a foot wide and, in some places, a foot deep. After that, it traveled through a phone line and caused damage to three homes. The bolt busted up a concrete driveway outside one home. It also damaged phone and water lines. Another home also had a phone jack busted off and melted carpet. Fortunately, no one was hurt during the storm."

I know one of the residents whose home was hit. All of the electrical outlets, switches, breaker box and every electrical or electronic device was simply fried. They were home during the strike and the static field was so strong that all of their hair stood straight out as though they were connected to a Van de Graaff generator.

I visited the home yesterday as inspectors were deciding if the home was salvageable.

They had removed large sections of the drywall and not only were the electrical fixtures fried, a 5' section of "Romex", three conductor power cable commonly used in the US that has hot, ground and neutral, has lost its ground wire! The remaining cable is full of burnt pinholes and there is copper bits buried in the 2x4 studs.

I watched as the pulled up the carpet and the concrete slab floor had the most interesting dendrite pattern. Large sections of the concrete will just lift out and much of the concrete is "pulverized". The foundation may have similar damage, or perhaps the lightning cut a underground trench which let water carry the dirt supporting the foundation away. One corner of the home sags over a foot.

What is interesting is the ground was saturated by the rain we have had in the last two weeks and the soil has not frozen. The earth path from the attachment point only approximates the buried telephone lines that it "followed". The actual attachment point was a small metal junction box that looks like a madman with an arc welder attacked it. The amazing thing is there are over 100 telephone lines in the box and the lightning path did not lead to the closest home. That home and most of the others only needed the exterior demarcation, or Network Interface Device, replaced.

Given the path length, and the massive damage, this strike has to be near the upper limits. I have some ~4" x 4" fused globs of sand and soil and a couple of globs of yellow clay that look as though they were fired in a kiln. My wife is an artist and this even impressed her.

The clay is very sponge like, very porous, were, I guess, the water boiled out. I expected to find only wet sand, clay and soil. A galvanized metal culvert had to be replaced as the lightning ran across the surface of the soil for maybe 25' and "exploded" the metal pipe.

There is a pronounced dip in the road where the pipe has failed. Looking in with a flashlight, hand torch, I could see thousands of dendritical burns, some of which had burned through the metal wall, exposing the dirt and gravel.

The state's chief fire marshal was there and he told me that in his 30 year career he had seen nothing close to this level of damage.

(Kindly sent in by Terrence Fugate, WN4ISX, on 26th January 2010. Terry's amateur radio gear was his only communication link with the outside world for three weeks after Hurricane Katrina.)

567) Overrun accident on Shonan Monorail officially caused by EMI

In 24 February 2008, there was an overrun accident on Shonan Monorail at Kanagawa, Japan. When the train started from a station on the scheduled time, it suffered unintended rapid acceleration. The train continue to accelerate even though the operator had not set the train's master controller to acceleration position.

When the train came near to the next station, it could not be decelerated enough even with its emergency brake activated, and caused an overrun. The train finally stopped, fortunately with no casualties, after collision with a rail point.

On 26 June 2009, an accident investigation report, RA2009-6, was issued from the Transportation Safety Board. The Board concluded that the accident was caused by roughly the following reasons:

1. Poorly grounded VVVF inverter (which drives the train) on the train caused excessive noise, which could be coupled to nearby wires;
2. A cable for an unused monitor board was still connected to the CPU, and the cable was not properly protected from possible incoming noise;
3. Noise on the cable could cause interrupt signal to the CPU;
4. The CPU didn't mask (disable) the unexpected interrupt, so the corresponding interrupt handler in the software could be activated due to the noise;
5. Somehow, once activated, the interrupt handler (not expected to be activated in normal situations) disabled all other interrupts after that, which made the acceleration/deceleration process no longer work at all;
6. The integrated watchdog timer couldn't recover the system due to a defect in the control software.

The moral of this story: especially for safety related systems, careful design and verification of the system, including its software, from an EMC point of view, is essential.

Reference for readers who can read Japanese: Accident investigation report RA2009-6, http://araic.assistmicro.co.jp/railway/report/detail.asp?ID=1744, or go direct to this PDF at: http://araic.assistmicro.co.jp/railway/report/RA09-6-1.pdf

(Kindly sent in by Tom Sato from Japan, on the 17 Jan 2010. The photograph below shows rescuers using an emergency chute to remove passengers from the crashed monorail train. I'd like to remind readers of the IET's very practical 2008 Guide to EMC for Functional Safety,

www.theiet.org/factfiles/emc/emc-factfile.cfm, which can be purchased as a colour-printed book from www.emcacademy.org/books.asp -Editor)*

568) Car door locks unstable when older car alongside

I would be very interested in seeing the risk analysis for any of the vehicles you mention in your article and more specifically for any system component that has changed from a hydraulic to electronic controlled. I can see issues with any system used for critical safety such as steering or braking. I am quite sure that a risk analysis for EMI has not been done to establish pass/fail criteria.

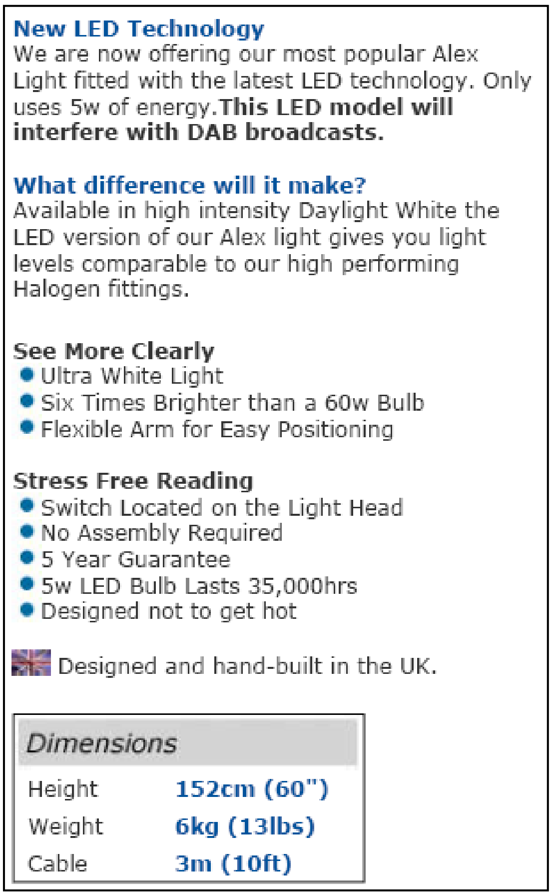
My own experience with a Ford car fitted with electronic door locking has convinced me that the EM environment is basically uncontrolled. Whenever an older car stopped beside me, the doors locked and unlocked until the vehicle passed by. Eventually after two sets of replacements the problem was fixed and I am sure was EMI related.

(Kindly sent in by Braham Bloom of EmiSolutions, Sydney, Australia, 21st February 2010.)

569) LED Reading light specified as interfering with DAB

Just found this on the web – a British made light that will interfere with DAB - who certified this one? Visit: www.seriousreaders.com/mall/productpage.cfm/SeriousReaders/_780001/255469/Alex%20LED%20Table%20Light.

(Kindly sent in by Peter Kerry, an independent EMC consultant in the UK.)



570) Rail industry doesn't understand EMI

During a coffee break at the IET Seminar: "EMC in Railways 2009", held at Savoy Place, London, on 12th Feb 2009, I met an old colleague who I knew was a proper EMC expert (as opposed to what the rail industry seems to think is an EMC expert), and asked them why it was that most of the rail industry believes that only in-band EM disturbances can cause EMI?

Given the safety-critical nature of railways, it seemed nothing short of astonishing to me that the whole industry should ignore (or deny) the many engineering issues that are responsible for most EMI incidents.

He said it was to do with the way dealing with EMC had evolved over many years on the railway and the historical focus on signalling equipment and a problem that he and his colleagues were trying to change, but were making slow progress. He then told me a story about a company that used very sophisticated coding to catch the incorrect data resulting from in-band interference and fail "right side" (railway-speak for fail safe).

Their calculations showed that this would occur so infrequently that it would not cause operational problems - the special coding was used "just in case", as a safety measure against what they thought of as the threats from EMI.

However, when their system was deployed in practice, the other kinds of EMI - the ones ignored or denied by most of the rail industry - caused their system to fail so often that it was never 'up' for long enough to be of any functional use. Needless to say an expensive investigation followed by remedial action was needed to render the system useable!

(Keith Armstrong, reporting a discussion during a coffee break at IET Seminar "EMC in Railways 2009", Savoy Place, London, 12th Feb 2009. There was such a strong reaction to this item from UK rail industry chiefs that an apology was necessary to avoid the threat of legal action, see below.)

Apology for Banana Skin No. 570, "Rail Industry Doesn't Understand EMI"

(The EMC Journal, May 2010, page 12)

I am very sorry that this Banana Skin has upset so many people. Although its complete title and most of its content faithfully reported the views of rail industry EMC experts present at that seminar, and the remainder of the material was my views, it was wrong of me to present the material in a way that tarred everyone with the same brush.

However, I am truly concerned that these railway EMC experts could make such allegations about the general state of understanding of EMI and EMC in the rail industry, especially as I have previously heard many other similar claims from other well-respected EMC experts working in that industry.

Should it turn out that these concerns are justified, then given the safety implications they are too serious to sweep under the carpet. Are there any responsible EMC engineers in the Railways industry who will remember the ethical obligations that came with their membership of the IET, and "blow the whistle"? The EMC Journal would print such articles anonymously and protect the sources.

Keith Armstrong

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The EMC Journal July 2010

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."

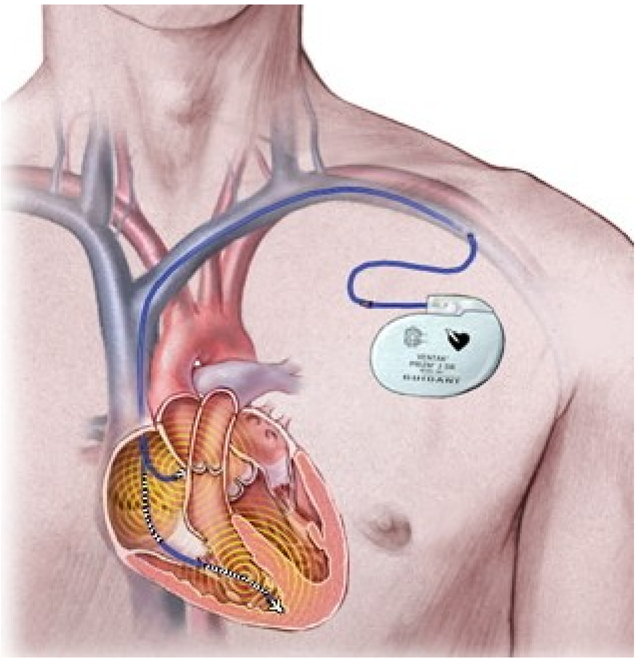
Again the date is unclear, but certainly early 1950s, probably 1951 to 1953. Source: Mike Hally, Electronic Brains: Stories from the Dawn of the Computer Age, Granta, 2006, pp. 171-2.

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 HeartRythm 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 electromagnetic 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.

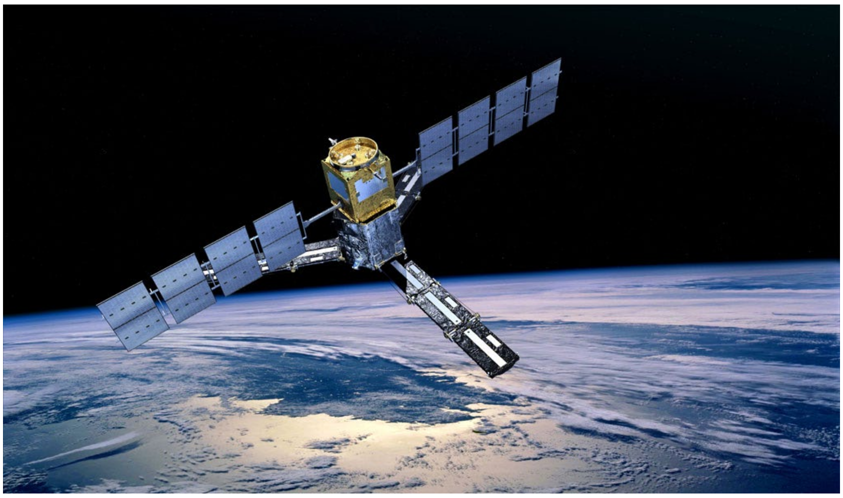
My colleague has learnt from this experience and has bought a petrol-engine scooter.

(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.

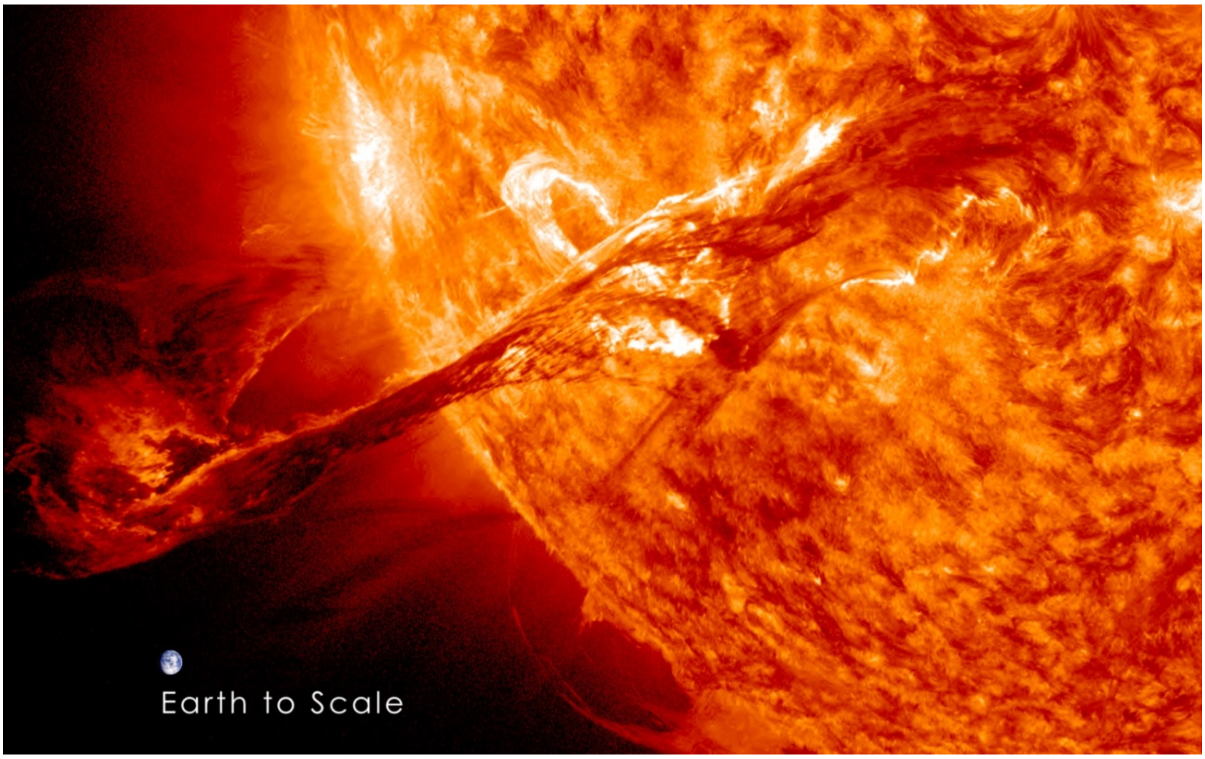


Figure 1 Example of a solar flare

(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.

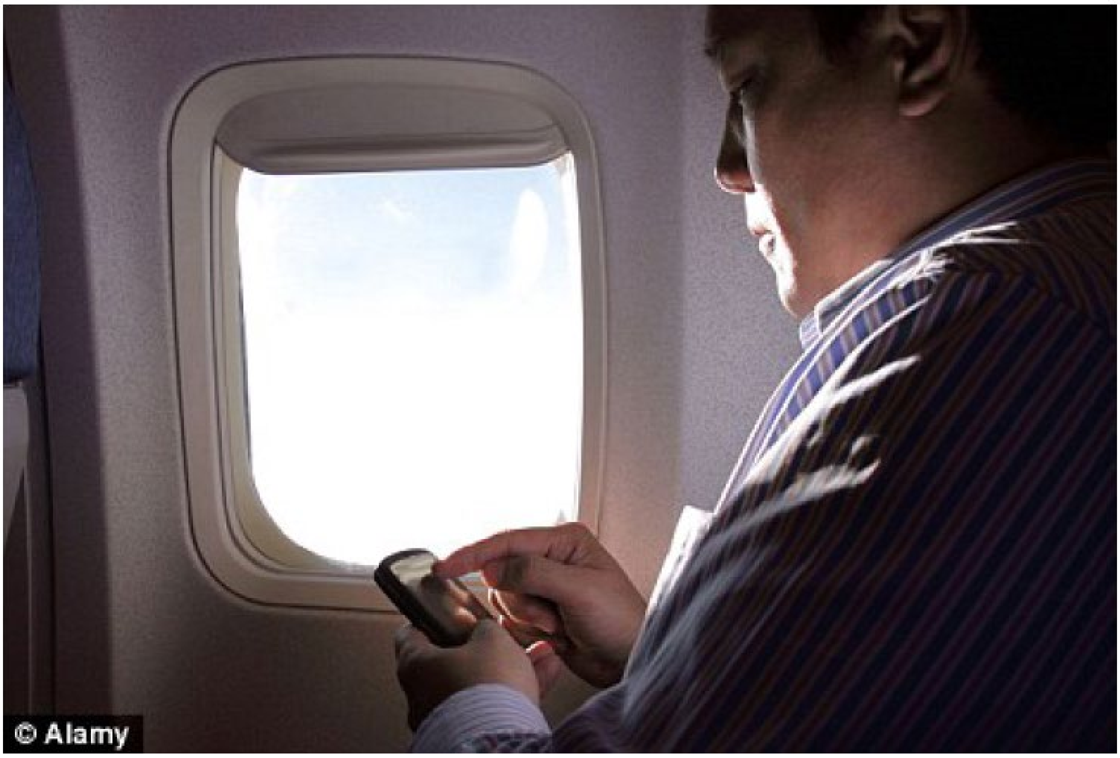


Photo: A businessman uses his mobile whilst in flight
(from the Daily Mail article referenced below)

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.)

CHERRY CLOUGH CONSULTANTS LTD

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)

666) Timely EMC fix on a satellite helped a lifetime’s career

The knowledge of having an EMC background can help all of you; in particular, what I am going to talk about is how it helped me in my career. When I first began my career back in 1951, for the first few years all I did was make EMC measurements. And then, one day, my boss quit for greener pastures and there was just a younger engineer and myself there at a large engineering design and development organization. I really knew nothing about EMC principles. I knew about measurements, but I didn’t know about principles. I had joined the IRE at the time as a student in college. I became active in the IRE and I looked to those people to help me gain knowledge in EMC. I was really helped. It was very challenging to me. It was invigorating and frustrating, but I learned many things.

After I learned, a company in Massachusetts made me an offer I couldn’t refuse. So I left RCA and went to Massachusetts. I was there for a while and since it was not my cup of tea, I left. I eventually came back to RCA at the RCA Space Center in Hightstown, New Jersey. It was called the RCA Astro-Electronic Division. They didn’t pay any attention to EMC, and I didn’t work as an EMC engineer. I had gotten out of EMC, but I was sucked back in by an event that changed my career, and really helped me.

I was working as a Reliability Engineer on a weather satellite for about three years. At that time, the weather satellites were relatively simple. Later generations were designed to give you the five-day weather forecast, but in those days they primarily were built to give hurricane warnings. But they kept on being improved to give you more and more data. Anyway, they built this weather satellite for the U.S. Air Force, but before they could ship the satellite, it had to pass ground simulation tests. Now, you have to understand that the way these satellites work, when it is overhead, what it does is it transmits the data directly to the Earth. But when it goes over the horizon, at that point the data is put on a tape recorder and the tape recorder then feeds it to a transmitter that transmits it to the next ground station. During these final simulation tests, they turned on both the transmitter and the tape recorder. The transmitter, low and behold, kills the tape recorder. Nothing intelligible came out of the tape recorder. There was a panic because that satellite had to be shipped in several weeks. If they didn’t ship it, there would be a lot of penalties monetarily and they might lose their turn on the launching pad. So, they had a team of managers, including the Chief Engineer of the Division, trying to solve the problem. But they weren’t using EMC principles. They kept turning the antenna of the transmitter around and kept trying to operate the tape recorder in a different way. None of these things worked. Then, someone remembered that several years ago I had worked in EMC. I was told to put a “bunny-suit” on and go in the clean area and see what I could do about this satellite. Of course, they didn’t pay any attention to me at the time because I was just an engineer, and they were all high level managers. So after they got tired they all walked out. There was one manager there, the manager of the design review team (because at RCA Astro, before you could release a design for space it had to undergo a design review process). He asked me, “Can you really solve this problem?”

I said, “Gee...I haven’t done this work for three years so I don’t know whether or not I can solve it. But if you want me to try, I need several things. First of all, I need priority in purchasing. I don’t want to go through any red tape to buy anything I need. Second, I need priority in the model shop; I want to be able to build a fixture over night and try it right away. Third, I need a mechanical engineer assigned to me so that whatever we come up with we can implement as a final design. He said, “You got it.”

This tape recorder was actually a sealed unit because it had to be vacuum protected. That made it easy for me. We couldn’t change the tape recorder, so, what we did is we designed an add-on box. This add-on box had three compartments; one compartment was for signal wires separated from the other two compartments. The second compartment was for command and control wires. The third compartment was for power signals. Each of the compartmental wires had to go through a bulkhead that was within this add-on unit. There were filters mounted on the bulkhead and the filters were of different strength depending on whether it was a signal wire, or a command and control wire, or a power wire. Then the big day came. We turned on both the tape recorder and the data transmitter and it worked (readable data was coming from the tape recorder). Somebody said, “Oh, I bet someone forgot to turn the transmitter on.” The transmitter was turned on...and it worked.

Following that, I became the go-to guy. Whenever there was an EMC problem they came to me. Whenever there was a proposal, they put my name in the proposal. I came up with a set of ground rules for EMC principles that the division had to follow. I got the blessing of the chief engineer that they had to be followed. Twenty years later, when I left RCA to retire, they were still following those EMC principles. This really helped me because several weeks after this event I went back to work as a Reliability Engineer; that was my job. Two weeks later I got a commendation letter. Several months later I got a call from the chief engineer’s office. I was invited to a dinner and I was to bring my wife. I was presented with an engineering excellence achievement award.

This helped me in other ways. There was a brutal layoff later on and since I had received this engineering excellence award they couldn’t lay me off, so I survived. What happened later on, I believe happened because of the recognition I received from this event. I became a group manager where I had responsibility for parts engineering, both passive parts and active parts, and for materials engineering. I was also responsible for reliability analyses and predictions, and for the failure analysis lab. And, yes, last but not least I was also responsible for EMC.

(Taken from “EMC War Story – by EMC Society Founder Vincent Mancino”, in the IEEE EMC Society Newsletter, Issue 216, “Winter 2008”, April 2008, page 60, www.emcs.org/acstrial/newsletters/winter08/war_story.html)

667) HDMI fails to meet the demands of low EMI

In recent years, the popularity of high-definition, multi-channel audio and video has grown rapidly. Radiation resulting from transmission of high-definition, multi-channel audio and video data at high frequencies often interferes with the operation of surrounding digital circuitry. Most existing audio video connectors and cables fail to meet the demands of low EMI at today’s and near future high clock and data speeds. One such existing connector intended for transmission of high definition multi-channel video and audio data is the High Definition Multimedia interface, which fails to meet the EMI requirements at high clock speeds.

(Taken from “Effects of skew on EMI for HDMI connectors and cables”, By Chaitanya Sreerama of Intel Corporation, Hillsboro, USA, in a paper presented at the IEEE 2006 International EMC Symposium, Portland, Oregon, USA, in August 2006, Conference Record: ISBN: 1-4244-0294-8, http://ieeexplore.ieee.org/iel5/11175/36004/01706346.pdf?arnumber=1706346)

668) How vulnerable are we to GPS jamming?

‘At the next left, you have arrived at the wrong destination!’ Just how vulnerable are we to the loss of GPS signals, and what can we do to reduce the risk from natural or malicious jamming? Christine Evans-Pughe finds out.

In January 2007 Captain Matthew Blizard, commander of the US Coast Guard Centre of Excellence for navigation (NAVCEN), reported the loss of GPS signals in the port of San Diego. Not only had the navigation equipment for general aviation stopped working but local telephone switches and cellular telephone operations were disrupted, and the hospital’s mobile paging system went down.

It took Blizard and his colleagues three days to pinpoint the source – a two-hour US Navy training exercise in communications jamming between tow ships in the area. When the Navy technicians found problems with the GPS systems on the ship under attack, they stopped the exercise but didn’t report the incident beyond their usual channels. No one told the GPS Operations Centre in Colorado (GPSOC) or VAVCEN about the exercise because the jamming was not meant to be in the GPS L-band.

A GPS jamming attack on the ship THV Galatea two years later off Newcastle-upon-Tyne showed some of the more subtle effects of jamming. Under low-power jamming, at about the same level as the real GPS signal, the ship’s GPS-driven bridge instruments showed plausible but wrong positions and velocities. No alarms went off to indicate malfunction. As the jammer power was turned up, all the GPS-fed systems failed including the electronic chart display, the autopilot, the maritime distress safety system, the radar, the gyro-compass and the Automatic Identification System, according to the General Lighthouse Authority who conducted the trial.

Vulnerabilities

If the Royal Academy of Engineering's recent headline-grabbing report 'Global Navigation Space Systems: reliance and vulnerabilities' is anything to go by, such scenarios are becoming more likely because of the availability of cheap GPS jammers. A £40, 10mW device bought off the internet, for instance, could stop a handheld receiver anything up to 10km away from acquiring a GPS lock. In the US, for example, one truck driver who didn't want his bosses knowing where he was used a jammer in his cab and caused daily interruptions to a GPS navigation system used by Newark airport in New Jersey.

One sign that the RAE's concerns are well founded is that the MoD has this year opened up its GPS jamming trials, which are usually for navigational warfare tests, to academia and industry. Qinetiq will be providing systems to generate a variety of signals for the session, which will take place at Sennybridge in the Brecon Beacons, Wales, between May and June.

"We need the hilly terrain so we can keep the jamming signals low. By putting the jammers close to the antennas, we can even operate in two or three different areas at the same time down in the valley," Qinetiq's business manager Peter Soar told a meeting in March about GNSS vulnerabilities at the UK's National Physical Laboratory.

Reflecting US government concerns about the economic impact of the disruption or loss of GPS signals, the US Department of Homeland Security has just surveyed 15 critical infrastructure sectors and found GPS essential to 11 of them, although it took many months to reach that conclusion, according to James Calverly, the Department of Homeland Security's director of outreach.

Position and time

GPS signals are used extensively as an accurate timing source, which was why telecoms and paging networks were affected by the San Diego Port incident. During the 2007 JAMFEST trial held at America's White Sands Missile Range, a series of 30-minute tests on GPS-disciplined quartz and rubidium oscillators showed all of them would have drifted outside the 1 x 1011 frequency offset requirements of the Stratum 1 clocks used to synchronise telecommunications systems in less than an hour, under every jamming scenario.

Power distribution networks, banking and financial trading system, broadcasting and industrial-control networks all use GPS timing in this way too, making them equally vulnerable to unintentional or deliberate (the civilian equivalent of navigational warfare) interference.

"The financial markets, for instance, rely on a globally synchronised time-stamping mechanism to ensure fair trading," explains the RAE report's author, Dr Martyn Thomas. "Trading systems might be detecting very small differences in prices between commodities on different exchanges and buying in high volume on one and selling on the other. Since lots of people are in competition trading on different continents, for these activities to work you need to know whose order is getting in first."

For these reasons, efforts are underway to encourage the use of back-up timing sources and to put in place ways of detecting, locations and mitigating sources of interference.

(Taken from "Jam Today", by Christine Evans-Pughe, IET Engineering & Technology, May 2011, pp 78-81, www.EandTmagazine.com)

669) The ultimate EM threat – "killer stars" – overload satellites' electronics

We know of well over 1000 pulsars. The number of quiet neutron stars must be vastly more. Even at the present rate of star formation, given the 10-billion-year life of the Galaxy's disk, there should be at least 100 million of them. There is probably one nearby, sliding silently past us, of no danger whatsoever.

The tiniest fraction, fewer than 20 known, are the extraordinary magnetars, which have magnetic fields so powerful as to be lethal at a distance of 1000 kilometers. Though they ally themselves with the remnants of supernovae, how they are created is uncertain. One strong suggestion is that they are the progeny of the most massive of stars, which lose so much matter through winds as they evolve as hypergaints that they don't have enough mass left to become black holes. If the progenitor stars were rapidly spinning so as to create the intense magnetic fields, they turn into magnetars instead. But, once again, we really don't know.

We do know the effects they can have, however. As spins of ordinary pulsars slow (the one in the Crab being a prime example), they undergo periodic "glitches" in which the rotations suddenly—and temporarily—speed up. The cause is thought to be a relatively modest "starquake", in which the strong magnetic fields re-adjust the neutron-star outer crusts. Magnetars, with magnetic fields up to 1000 times those of ordinary pulsars, take this behaviour to an extraordinary extreme.

As rare as magnetars are, they have an even rarer subset known as "soft gamma-ray repeaters", or (to add to the alphabet soup) SGRs. Only five are known, and one of these is in our nearby companion galaxy, the Large Megellanic Cloud. Brief X-ray pulses reveal them to be long-period (many seconds) pulsars, placing them in the magnetar clan. If the Crab pulsar has a thing called "starquake", it's hard to know what word to use for these things.

On August 27, 1998, SGR 1900+14 in Aquila (the numbers are coordinates) launched one of the greatest stellar attacks ever seen on Earth, from a mega-starquake, in which twisted magnetic fields attempting to re-align themselves cracked the magnetar's crust. In a pulse that lasted less than a second, the resulting flood of gamma rays hitting us overloaded satellites' electronics, and amazingly ionised the Earth's upper atmosphere. Within a few hundred seconds, the event and its aftermath were all over with. SGR 1900+14 is 20,000 light-years away.

On December 27, 2004, SGR 1806-20 (in Sagittarius) outdid its Auila cousin by a factor of 100. For a brief instant, a couple tenths of a second, an outburst of energy the equivalent of half a million years'-worth of sunlight shone on us with the apparent light of more than a full moon (in gamma rays: you could not have seen it). Once again, many satellites and the upper air took a huge hit. SGR 1806+20 is estimated to be 50,000 light-years away, on the other side of the Galaxy. And it was not the first time! The magnetar had previously popped in 1974. And it will most likely do it again before these pages turn brittle with age.

(Taken from "Heaven's Touch – from killer stars to the seeds of life, how we are connected to the universe", by James B Kaler, Princeton University Press 2009, ISBN: 978-0-691-12946-4.)

670) How EMI can become a problem

Electromagnetic Interference (EMI) can become a problem when emitted electromagnetic fields interfere with the operation of other electronic equipment. Electromagnetic fields are radiated from sources such as equipment for television, cellular telephone, radio communication, computer, radar, and other devices. EMI could also take place due to distant sources such as radio transmitters, antennas, and lightning, which make incident electromagnetic fields similar to plane waves.

Common examples of EMI include disturbances in television reception, mobile communication equipment, medical, military, and aircraft devices, in which interference could disturb or jam sensitive components, destroy electric circuits, and prompt explosions and accidents.

(Taken from: "Simple device for electromagnetic interference shielding effectiveness measurement", by Horacio Vasquez, Laura Espinoza, Karen Lozana, Heinrich Folz and Shuying Yang, IEEE EMC Society Newsletter, Issue 220, "Winter 2009", www.emcs.org/acstrial/newsletters/winter09/pp2.pdf)

671) Lightning strikes to aircraft still an expensive and important problem

As aircraft safety becomes more and more critical, the risk of lightning strikes is becoming a more important problem for designers. Hannah Jeffrey looks at a new test regime that allows the effects of such an event to be simulated.

On average every civil aircraft is struck by lightning once a year. That may not sound serious – most passengers would suggest there are more pressing things to worry about when flying these days besides the chance of a lightning strike – however (sufferers of aviophobia – fear of flying – should look away now), lightning can cause planes to fall out of the sky. "The first known example I have is a Boeing 747, which was hit by lightning over Madrid in the 1970s or late 60s," says Chris Jones, technologist consultant in the electromagnetic engineering department of BAE Systems. "It literally just fell out of the sky when the wing exploded. It may not happen that often but the potential for damage is quite serious." He suggests this is also a significant problem for military aircraft: "Strike rates for planes carrying out military roles vary – the Nimrod flies close to the sea in rigid patterns, so it can have a high strike rate, but Eurofighters don't tend to fly where they could be high by lightning." Accidents do of course happen, but, scaremongering aside, serious electrical faults can be caused by lightning strikes and, as electronic systems within aircraft become more numerous and increasingly safety critical, this is progressively becoming a more important problem for designers and manufacturers in the aerospace industry to consider. "You have tens of boxes with hundreds of functions," says Jones, "and for many of these just interrupting their function could result in the loss of the aircraft. But also we are using more carbon fibre composites in the construction of aircraft now, particularly in military aircraft. Whereas the aluminium previously used was more like a solid wall and you only had to worry about holes in the – it reflected most of the energy – carbon fibre is more like a window, so you're letting some of the energy through. There is therefore an increased possibility of damage and the aircraft is more vulnerable."

Testing

According to Jones, "Civil aviation regulations require a plane to be safe for 1011 flying hours at least and the figures are similar for military craft." However, it is more expensive to test military aircraft and yet, because their electronic systems are often much more complicated and sensitive than those in civil aircraft, they can require more rigorous testing. Until recently in the UK, says Jones, "Military aircraft testing of this sort was carried out quite haphazardly. In this country it was only really in the process of research that it was considered. I only know of the experimental version of the Jaguar fly-by-wire and the prototype Eurofighter being tested. Before, there was no lightning clearance, only electromagnetic compatibility." (EMC – the requirement that electrical equipment resist the influence of electromagnetic emissions in the surrounding environment and not generate interference itself, in order to comply with certain standards). He continues: "You had to make assumptions but these were reasonable assumptions. Nevertheless, in the late 1970s NATO countries lost on average one plane a year." Lately we have been doing better, he reassures, but this is still an expensive and important problem.

(Taken from "Strike it lucky" by Hannah Jeffreys, Engineering magazine, Aerospace section, www.engineeringmagazine.co.uk. Sorry, the date of the reference has been lost, probably 2008 or 2009 - Editor.)

672) Some types of MR16 LED lamps interfere with DAB radio reception

To Peter Metcalfe of Metecc, August 19, 2011 at 16:59:59

I have been advised to contact you as you have done extensive testing on LED lights for Trading Standards. I would like to know what types of MR16 LED lights do NOT destroy the DAB radio signal in my house. (I have just bought 30 MR16s and whenever I switch any of them on, the DAB radio loses signal and is useless. I also get some mild interference on the FM radio.

To Peter Metcalfe of Metecc, 21 August 2011 at 12:32

Thank you for your comprehensive response.

Yes, I discovered that the 230V LEDs are fine - I bought 36 of them from the same company (internet / mail order), and they have not caused any problems with my radio. They are GU10 80 LED by Mirrorstone.

The problem bulbs are MR16 LEDs - I bought 9 x 4W and 21 x 6W. They came in a small unmarked white box, no manufacturer shown, and just marked CE and RoHS. They don't show AC/DC.

I shall certainly take your advice and return the MR16 LEDs tomorrow, and demand my money back. The company has already said that they would be happy to do that, but, given that they have been 100% helpful so far, I wanted to give them a chance to find some non DAB interfering MR16 LEDs to sell to me.

The company told me that it was unaware of the DAB interference issue, and was going back to its supplier / manufacturer. The company also told me it was not aware of any regulations regarding compliance with radio interference. (By the way, if they do tell me they have found non DAB interfering LED bulbs, how can I tell if that is true, short of buying them and trying them? What marking / Standard should be shown to prove compliance with UK Law?)

From what you have said, it sounds like I shall either need to put up with the cost of running the MR16 Halogens, or I shall need to get an electrician in to adapt the MR16 fittings so they can take GU10 LEDs - by removing the transformer. Do you have any better suggestion?

I spent a lot of Friday trying to find someone who was knowledgeable about this issue. The order of my enquiries was as follows – each one suggesting the next one:

a) The Consumers Association (Which?)
b) Ofcom
c) Consumer Direct
d) British Standards Institute (who first suggested Trading Standards, but I noted that their phone number was the same as Consumer Direct)
e) UKAS

f) NEMKO Ltd

g) Hursley EMC, where Julian Jones suggested that I contact you.

Thank you again for your help. I would be very interested to hear your suggestion for a solution to the problem of replacing MR16 Halogens. Meanwhile I shall speak again to those companies I spoke to on Friday and try to interest them in this issue, as I don't want anyone else caught out in the same way. Equally I would be upset if my neighbours in adjoining houses did the same and knocked out my DAB. I am going to ask them whether their DABs have been affected in the last week, and apologise if necessary.

To Peter Metcalfe of Mettec, 21 August 2011 at 17:11

I just switched on all the MR16s, 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.

(Extracts from an email correspondence forwarded to Banana Skins by Peter Metcalfe of Mettec, www.metecc.eu, the other party wished to remain anonymous.)

673) European Space Agency Shuts Down Illegal Transmitters

An international effort to shut down radio signals that have occasionally been blocking the instrument on ESA's Soil Moisture and Ocean Salinity (SMOS) water satellite is improving the quality of the mission's data.

The SMOS satellite carries a passive radiometer that operates in the 1400–1427 MHz frequency range (L-band) of the electromagnetic spectrum. It shows 'brightness temperature' that corresponds to microwave radiation emitted from Earth's surface. From this information, the amount of moisture held in the surface layers of soil and salinity in the surface waters of the oceans.

According to radio regulations set by the International Telecommunications Union (ITU), 1400–1427 MHz is alloted to the Earth Exploration Satellite Service, space research and radio astronomy; other transmissions in this band are prohibited.

Soon after SMOS was launched, the data revealed there were many signals being transmitted within this protected passive band, rendering some of the data unusable for scientific purposes. The mission has not been reaching its full potential because significant amounts of data have had to be discarded.

As a result of ESA's strategies, 90 of these transmitters have been turned off. Most of these were in Europe but investigations continue in more than 35 countries worldwide.

(Copied from Interference Technology Magazine, www.interferencetechnology.com/lead-news/article/european-space-agency-shuts-down-illegal-transmitters.html, 06/15/11 04:58 PM. Learn more from: www.redorbit.com/news/space/2064081/smos_gains_clearer_view_as_illegal_transmitters_sut_down/)

674) Military radios interfering with garage door openers

US homeowners are encountering some unusual problems with their garage doors. The Pentagon may be to blame. Not because of any grand conspiracy theory, but rather the mundane use of a radio frequency the military hadn't used much before.

US homeowners in coastal Orange County, California, are among the latest to discover this quirk. There, signals from Naval Weapons Station Seal Beach have been interfering with garage door openers as far as half a mile (0.8 kilometres) away since March.

That's when testing began on a new radio system that will allow the base to network with local fire and police agencies during emergencies. The frequency falls in the range of 380-399.9 MHz, a band long reserved for the Department of Defence but rarely used.

"We hadn't had the need to use these frequencies before. As a result, garage door manufacturers began using them because they were pretty quiet," said Gregg Smith, a spokesman for the Navy station. "With the explosion of communications technology over the past 20 years, the DOD has been squeezed to use bands it didn't need to use before."

Reports of interference with garage door openers near military installations have been reported from Rhode Island to San Diego to Hawaii.

"Out of the blue, the garage door just stopped working," said Bill Davey, 51, of Norco. "We changed all the batteries in the remotes. When it still didn't work, it was like 'What's going on here?'"

The culprit was a Navy installation a quarter-mile (0.4 kilometres) away.

The Federal Communications Commission allows the so-called unlicensed use of frequencies for low-power purposes such as garage door openers and vehicle key fobs as long as they don't interfere with government communications systems, Smith said.

Smith said he's fielded 16 complaints from people near the Seal Beach base, but he assumes the interference is affecting many more. People can buy a device to retrofit their openers to another frequency; Davey's cost $US60.

"Once you explain how it all works, folks aren't happy, but they've been understanding," Smith said.

(Kindly sent in by Chris Zombolas, of EMC Technologies Pty Ltd, who operate EMC test labs in Melbourne and Sydney, Australia, and Auckland, New Zealand. Written by Mike Anton of the Los Angeles Times, reported in the Sydney Morning Herald, June 3, 2011 - 8:38AM, www.smh.com.au/technology/technology-news/military-radios-interfering-with-garage-door-openers-20110602-1fj5d.html. Read more: www.smh.com.au/technology/technology-news/military-radios-interfering-with-garage-door-openers-20110602-1fj5d.html#ixzz1OCjQqMdb. Also reported by Interference Technology Magazine at: www.interferencetechnology.com/lead-news/article/seal-beach-navy-transmitters-control-residents-garage-doors.html as "Seal Beach Navy Transmitters Control Residents' Garage Doors" posted 06/01/11 09:06 AM, which referred to an ABC article: http://abclocal.go.com/kabc/story?section=news/local/orange_county&id=8157525&rss=rss-kabc-article-8157525)

675) Excessive emissions from Plasma TVs despite passing relevant tests

22 September 2011 at 08:42

Hi John and Keith. On a different subject I recently had to complain to OFCOM about noise across the lower HF spectrum at home (roughly 1.5 to 6 MHz), the problem turned out to be 2 plasma TV's, the level being radiated was similar to PLT. OFCOM walked away from this Plasma TV problem saying there was nothing they could do. Best regards, Tim.

22 September 2011 at 09:25

Hi Tim and Keith. CISPR are aware of this issue. Radiated emissions from plasma TVs below 30 MHz has been a concern for a couple of years. It's a difficult challenge from a standards point of view.

However, this seems like further evidence that OFCOM are relinquishing their responsibilities regarding EMC/interference. Best regards, John.

22 September 2011 at 09:40

Hello John and Keith. The attitude of OFCOM was that the TVs in question exhibited the CE mark, one was a LG set, not sure about the other, they may well have passed Radiated Emissions above 30MHz and Conducted below, but because the standard does not call up a radiated emissions test below 30MHz then the equipment must be OK even though the devices are causing significant spectrum pollution.

It's interesting to note that Panasonic do acknowledge that they have a problem and in some cases have removed and replaced the offending sets. Best regards, Tim.

22 September 2011 at 12:26:16

Hello Tim and Keith. That is exactly the issue with large plasma TVs. They pass the testing in EN 55013 (radiated above 30 MHz and conducted below). They are perfectly compliant with the standards and the many TV manufacturers that I know are highly responsible in making sure their products do meet standards. However, the discharge arcing of the plasma is causing radiation below 30 MHz, which is not picked up in the tests of EN 55013.

The problems CISPR have is to create a test for near field measurements (electric or magnetic or both). Where to measure, repeatability issues and various other issues are in the mix also. Best regards, John.

24 Sep 2011

Hello Keith and Tim. This issue has been discussed several times at BSI, not just in CISPR. The concern to address this also seems to be fading because plasma TVs are now considered to be old technology with the recent advances achieved in LED TV. I believe that many TV manufacturers are no longer making plasma TVs. Best regards, John.

(Extracted from an email discussion between Tim Hague of Amplifier Research, thague@arworld.us, John Davies of EMC Goggles, john-davies@emcgoggles.com, and Keith Armstrong, cherryclough@aol.com, the editor of Banana Skins.)

676) EU Spectrum Policy Does Not Answer Interference Questions

Latest negotiations that pave the way for a coherent set of rules on new spectrum use are poised to help the EU achieve the much talked about Digital Agenda. The Commission has made a clear call to Member States to put in place procedures to promote coexistence between new and existing services. But the latest text of the new Radio Spectrum Policy Programme (RSPP) falls short of capitalizing upon efficient use of spectrum if new services interfere with existing services.

The latest developments give hope that the European Commission wishes to promote competition, investment and the efficient use of spectrum. However, back in 2009, Cable Europe issued a call to the Commission and EU member states to take interference to a range of existing services into account. In the current absence of an answer of how to respond to potential interference, future spectrum challenges for consumers will need to be examined more closely.

Cable Europe published a News Release in Brussels on 15 November 2011, entitled "Getting European Spectrum Policy Right Through Coexistence — EU deal leaves key questions on coexistence between new & existing services unanswered; Who's responsible if new services create interference?"

In this document they said: "However, back in 2009, Cable Europe issued a call to the Commission and EU member states to take interference to a range of existing services into account. In the current absence of an answer of how to respond to potential interference, future spectrum challenges for consumers will need to be examined more closely."

"The interference issue is not new. It was signaled to the European Commission and national administrations as soon as it was identified," says Cable Europe Labs Managing Director, Peter Percosan. "Spectrum in Europe is something that almost every single EU citizen relies upon daily in some form. Given its importance, it is disappointing to see that interference has not been given adequate attention on the technical level. Technical bodies, such as CEPT, have an important role to play in ensuring coexistence. However, CEPT has not agreed to look into interference with consumer equipment as we anticipate new spectrum needs for new technologies such as cognitive radio. We all know that there will be a growing cocktail of devices and getting those to work together is critical for Europe and its Digital Agenda."

(Taken from www.interferencetechnology.com/standards-update/article/eu-spectrum-policy-does-not-answer-interference-questions.html 11/17/11 11:10 AM and www.cableeurope.eu/uploads/MediaRoom/documents/111115_gs_News%20Release_EU%20Spectrum%20developments%20FINAL.pdf.)

677) Electromagnetic Interference Enables/Disables GM Airbags; GM Forgets to Inform Customers

What happens when you put your iPad on the front passenger seat of a 2012 Buick Enclave?

That depends on which General Motors (GM) source you consult. In May, the automaker sent out a Technical Service Bulletin warning that when "certain electronic devices" such as computers, MP3 players and cell phones are placed in the front passenger seat of a wide range of recent models, the front passenger airbag indicator may illuminate, enabling the airbag, and activating the seatbelt reminder light and warning chime – due to electromagnetic interference (EMI). Even though that iPad only weighs 1.5 pounds, the seat sensor suddenly thinks that this designated seating position is occupied. More recently, an OnStar operator told a GM owner that if a passenger is seated in the right front seat with an electronic device in his or her lap, EMI may disable the airbag. In other words, if the sensor correctly perceives that an occupant is in the seat, then interference from the iPad tells the sensor to turn the airbag off. In complaints reported to SRS GM owners said electronic devices held by a front seat passenger turned off the passenger airbag.

"We called OnStar and spoke to a tech," said one owner. "He confirmed that this can be caused by cell phones and cell towers." If one consults the owner's manual of a 2012 Buick Enclave (which is among the models covered in the May 25 TSB), it warns: "The front passenger safety belt reminder light and chime may turn on if an object is put on the seat such as a briefcase, handbag, grocery bag, laptop, or other electronic device. To turn off the reminder light and/or chime, remove the object from the seat or buckle the safety belt." Is this a warning about lightweight objects triggering a seatbelt sensor? Does the seat sensor confuse an iPhone with an occupant too small for safe protection from the airbag? Or, more likely, is this an obfuscated EMI warning? The owner's manual is silent on this caution.

The May 25 TSB covers 12 models over the 2009-2012 model years. It warns "some electronic devices placed on the front passenger seat may interfere with the electric field generated by the PPS system, causing it to enable (turn ON) the passenger airbag and turn on the safety belt reminder light and chime" – even though the seat is not occupied.

The electronic device does not necessarily need to be turned on to cause this condition." It also cautions techs: "Never rest the diagnostic scan tool or components on the passenger front seat or touch the passenger front seat while the diagnostic scan tool is in contact with your body. This may cause the SIR lamp to illuminate while holding the diagnostic scan tool because your body can transfer the electronic 'noise' to the sensor mat in the passenger front seat." (This may explain what happens when a right front seat passenger uses a cell phone.)

The fix was to simply clear the codes – which could relate to a variety of error messages involving the seat sensor or the ECU – and send the customer on his way.

If the GM owner lives in the Texas Panhandle, however, the problem is worse, and requires a more intensive fix. On May 25, 2011, the automaker issued a second and unusual warning for techs in Texas. This TSB warned that the airbag warning light could behave erratically in the presence of EMI. "This condition may be caused by possible electromagnetic interference in the Amarillo, Texas area from external sources such as aviation airspace traffic radar, creating erratic sensor information to the SDM," the bulletin said.

This TSB covered 18 models in the 2010 and 2011 model years. In this case, the techs were required to amend the sensor by adding ferrite clamp beads (Laird Part No. HFA100049-0A2) on either side of the inflatable restraint sensor wire harness.

There are several international voluntary standards and vehicle manufacturers have set their own criteria governing EMI, but no Federal Motor Vehicle Safety Standard. But as the world goes ever more wireless, are automakers and NHTSA keeping up?

According to EMI Expert Keith Armstrong, "some vehicle manufacturers' standard tests only apply to the normal operating functions of the components and subsystems. For example, an airbag should not operate, a speedometer should show the correct speed within specified tolerances, etc., but they lack requirements to test the correct operation of safety systems, by stimulating them with a signal that should make them operate, and check that they always do operate as designed whilst exposed to EM disturbances."

As the transformation of an automobile continues from a collection of mechanical parts to a computer on wheels with communication interfaces to non-vehicle wireless devices from the driver and passengers inside, or from sources outside the vehicle, today's vehicles are expected to function correctly in a very noisy electrical environment.

(Taken from: The Safety Record, Volume 8, Issue 3, November 2011, published by Safety Research and Strategies, Inc., www.safetyresearch.net.)

678) Early mobile phone interfered with aircraft navigation

Vic Eliason, while remeniscing on the daily "VCY Today" on an American radio station VCY America, told of the early days. What has grown into VCY America began about 50 years ago with borrowed equipment - they did not even own a microphone stand.

Vic remembers their first cell-phone. It weighed about 9 lbs, and had a 5 watt transmitter. This made it useful for outside broadcasts. But they soon learned not to use it in an aircraft. It interfered with the navigation equipment, and every time they pressed the "TALK" button, the aeroplane would veer off course as the pilot adjusted to what the navigation instruments showed.

(Kindly sent in by Robert Higginson, a regular contributor to Banana Skins, who produced the above summary from memory immediately following the broadcast VCY Today on VCY America when presenter Vic Eliason reminisced about the early days of that station which began 50 years ago.)

679) RF susceptibility of Phantom II Aileron-Rudder Interconnect (ARI)

Like many UMR graduates, Doug went to St. Louis to work for McDonnell Aircraft, eventually McDonnell-Douglas, and now Boeing. Mr. Mac probably rolled over in his grave after the Boeing takeover/merger (many say that MacAir took over Boeing, but that is out of scope for this profile).

One of his most enduring of the MacAir educational experiences dealt with the RF susceptibility of position-transducer-fed flight control avionics. The Phantom II (F/RF-4) aircraft was in production during that era and included an Aileron-Rudder Interconnect (ARI) circuit.

Signals from position transducers on each aileron were added, amplified, and used to control a hydraulic valve to add a small amount of rudder when turning. The Wright Brothers had a mechanical method to do the same to connect their wing warp and rudder on the original Wright Flyer. The hip cradle controlled it – they literally flew by the seat of their pants.

Emissions from on-board communications transmitters would couple into the wiring between the aileron position transducers and the ARI amplifier at the vertical stabilizer base. It even happened once during an important sales flight when the Shah of Iran came to St. Louis to purchase some F-4s.

He was flying the back seat of an RF-4 and noted controls for the high-frequency (HF) radio. The Shah received permission from the pilot to operate aeronautical mobile on the HF ham bands using his ham radio license. It was embarrassing when his ham transmission caused the rudder to move.

Doug was taught that there is no such thing as an uncommanded flight control surface movement. Increased wire shielding and ARI amplifier filtering fixed the problem. Doug participated in the ARI and nine additional air safety investigations during his five years at MacAir.

(One of several anecdotes of aircraft EMI mentioned in “EMC Personality Profile — Introducing Douglas J. Hughes” by Bill Duff, Associate Editor, IEEE EMC Society Newsletter, Fall 2004, www.ieee.org/organizations/pubs/newsletters/emcs/fall04/personality.html. Doug is still involved in EMI investigations, as an independent, and his email is w3ho@aol.com.)

680) Reason why pilots ban use of personal electronics below 10,000 feet

In USA Today’s “Ask the Captain” column, a reader challenged in-flight electronics rules, questioning whether electronics with low EMF emissions, such as electronic book readers, cell phones and computers, interfere with in flight instrumentation. The reader points out that American flights with GoGo inflight wireless access points are enabled throughout the flight. From takeoff to landing these wireless access points are continuously operating and emitting their wireless signals.

The concern of the FAA is that an electronic emitter could cause unintended consequences to navigation receivers or other aircraft systems, said John Cox, a retired airline captain with U.S. Airways who runs his own aviation safety consulting company. Ongoing changes in electronics make it very difficult to test all the devices to ensure their safety, and during some phases of flight, the navigation system is more sensitive than others, Cox said. “An example is during an approach for landing using the Instrument Landing System (ILS). The display uses microvolts to displace a needle showing the extended centerline of the runway. As the airplane flies the ILS course, the needle becomes more sensitive (think of it as a cone with the top of the cone at the runway).”

The FAA has developed criteria for electronic devices proving their safety, but it is much more difficult for the FAA to evaluate the effects of the use of untested electronics. Hence, the ban on all electronic devices below 10,000 feet.

(From “Retired Captain Answers Challenge to In-Flight Electronics Rules” at www.interferencetechnology.com/lead-news/article/retired-captain-answers-challenge-to-in-flight-electronics-rules.html, 10/05/11 03:25 PM, which references the original USA Today story at: http://travel.usatoday.com/experts/cox/story/2011-10-03/Ask-the-Captain-A-reader-challenges-in-flight-electronics-rules/50634340/1?csp=Dailybriefing.)

681) Inflight Wi-Fi hits more turbulence

Inflight Wi-Fi and cellphone services - which transmit low power microwave radio signals within an aircraft's fuselage – have already been criticised by security engineers for providing a ready means for terrorists to remotely detonate explosives. Now the technology has been found to be interfering with flight critical electronics too.

This latest finding was made by Boeing while testing inflight Wi-Fi equipment for use on its next generation 737 twin-engined aircraft. The Seattle-based plane maker found that a certain type of new, brighter cockpit display made by Honeywell of Torrance, California, could go blank when an inflight wireless system, made by Aircell of Itasca, Illinois, was used nearby.

"Blanking of the display units was reported during electromagnetic interference certification testing of wireless broadband systems (Wi-Fi) on various 737NG airplanes," Boeing said in a statement issued today.

The firm adds it has not delivered any aircraft using the technology and will not activate any passenger Wi-Fi systems in future planes across its whole range of aircraft until Honeywell has made its new displays Wi-Fi proof.

In 2000, the British Civil Aviation Authority borrowed a couple of airliners - a Boeing 737 from British Airways and a 747 from Virgin Atlantic - and generated simulated GSM cellphone signals in them. As New Scientist reported, they found that avionics equipment in the cockpit were susceptible to high levels of interference - the first "scientific proof" there was an issue, said the CAA.

Commercial pressures to allow lucrative wireless services on board, however, led to the development of electromagnetic shielding standards for avionics equipment, designed to ensure that emerging portable electronic devices like smartphones and laptops using 3G and Wi-Fi connectivity did not cause problems.

It was while testing to the US Federal Aviation Administration's relevant standard that Boeing found the Aircell system interfering with the new "phase three" Honeywell multifunction cockpit displays, which are brighter then their predecessors.

The interference happened at Wi-Fi signal levels that are higher than is normally emitted by phones and laptops, Boeing says, but it is quite possible for consumer equipment not to perform to specification and kick out too much power - so no chances could be taken.

"We have identified a fix and are working to ensure that temporary blanking does not occur when displays are exposed to elevated levels of electrical energy," a Honeywell spokesman told New Scientist.

The FAA is on the case. "We are aware of some issues involving interference between Honeywell flight displays and in-flight Wi-Fi that surfaced during certification testing," says Les Dorr, FAA spokesman. "We are currently working with both manufacturers to examine the technical data and test results. After a thorough review, we will consider if further safety action is necessary."

(From "Inflight Wi-Fi hits more turbulence" by Paul Marks, New Scientist, 20:39 10 March 2011. www.newscientist.com/blogs/onepercent/2011/03/inflight-wi-fi-hits-more-turbu.html.)

682) My neighbour's telly has broken my car!

An £80 TV transmitter box is being blamed for 140 cases of car key fobs failing over the past year.

Ofcom says that the 'TV senders', which plug into a satellite receiver and send the signal wirelessly to other TVs in the house, can jam the key fobs of an entire street's worth of cars.

It happened recently on Dimond Road in Southampton, when residents were baffled one Saturday morning to find that their cars wouldn't unlock.

The amount of fobs that had simultaneously failed suggested that battery failure on each was too coincidental.

Ofcom was called out to investigate, and found that one house had a TV sender.

A spokesman said that a "leakage" from the device, transmitting at the same frequency as the key fobs, was to blame. It asked the resident to switch the faulty box off, which worked – all the fobs began to work again instantly.

According to Ofcom, it has to send teams of people door-knocking when a case is reported on a street, to see how many people have been affected and work out who has the offending box.

So the moral is: if your neighbor insists on watching Sky in his bedroom without paying for Multiroom, the least you can do is buy an old car...

(Kindly sent in by Sandy Armstrong, from AOL's autoblog, by Mark Nichol, Nov 4, 2011. This report closes the case reported below – dated 12 October 2011.)

Electronic car key fobs have mysteriously stopped working along part of a Southampton street, according to residents. On Saturday, people living on Dimond Road in the Bitterne Park area found their fobs would not open their cars.

Madeleine Wentworth said: "It's really annoying, I don't like not knowing what's causing it."

It is thought the problem is being caused by interference with the radio frequencies used by the fobs. Brian Deadman described it as "baffling" and said his key fob worked perfectly well away from Dimond Road.

Neighbours have speculated about the interference being caused by a mobile phone mast or the nearby Southampton International Airport. An airport spokesperson said it had not changed any of its frequencies.

Ofcom said residents could contact them and log a complaint which they would investigate to pinpoint the cause of the interference.

A spokesman said it was likely to be due to a signal from a malfunctioning electronic device "leaking" on to the spectrum of the key fobs.

AA technical specialist Steve Evans said the motoring organisation received about 40 call-outs over key fobs not working each month in the south – usually caused by flat fob or car batteries, or radio interference.

Mr Evans said: "If it is a problem with radio interference, try getting closer to the car and then try walking around the car - the receivers are placed in different places on different cars."

(Taken from: "Electronic car key fobs fail on Southampton street" *BBC News, Hampshire & Isle of Wight, 12 October 2011, 13:42 ET, www.bbc.co.uk/news/uk-england-hampshire-15278838. This was very kindly sent in on 13 October 2011 by Tim Williams of ELMAC Services, www.elmac.co.uk; Claire Ashman, EMC test lab assessor for the United Kingdom Assessment Service (UKAS), and Les McCormack of Atkins. Les also provided some solutions he was involved in some time ago, at: http://yorkemc.co.uk/research/low-power-radio/LPD_Guide.pdf, and http://yorkemc.co.uk/research/low-power-radio/LPR.pdf.)*

683) Domestic products interfere massively with AM and FM reception

"The article shows a very nice antenna. I've built several less sophisticated than that design already and they don't get the job done. What I really want to do is put an FM antenna on the roof complete with amplifiers and rotor.

The current system with any antenna in the room has to fight off local interference, especially from the new electric blanket.

It seems like FCC class B requirements are no longer being enforced, especially on cheap import products. The control on the electric blanket is the second new product we have gotten that massively interferes with all the radio broadcast bands, both FM and AM reception."

(Kindly supplied by Steve Webb of SELEX Galileo, on 18 October 2011, the second reply, from Ed Weldon: http://cr4.globalspec.com/thread/72947/FM-Radio-External-Antenna-Connector?frmtrk=cr4digest.)

684) M2M GSM module interferes with its own and a neighbouring machine

At the moment, our lab is facing the problem of an M2M (machine-to-machine) GSM module perturbing the machine itself !!! (The reason is bad termination of a shielded cable ... once more.) Also, it is perturbing a sensor on a nearby machine.

(Taken from private correspondence with Keith Armstrong, 20 September 2011. The author wishes to remain anonymous. M2M, like RFID, is a rapidly growing "business opportunity", and M2M suppliers estimate its global market size for GSM transmitters to be double that for cellphones, visit: en.wikipedia.org/wiki/M2M.)

The Editor writes: This Banana Skin highlights a very important issue for the RF immunity of safety-related electronic systems, until now designed to meet quite low RF field strengths, e.g. 3V/m or 10V/m, on the basis that operators will not use their cellphones or walkie-talkies nearby. This is called creating an "RF Exclusion Zone", and I doubt that they have ever worked very well unless actively and continuously enforced – see Banana Skin number 684 (below) and 651 (July 2011).

But with RFID readers soon being used almost everywhere for operational reasons, and M2M transmitters invisibly embedded into items of equipment, as well as wireless transmitters hidden in items that one doesn't think of as a cellphone or walkie-talkie (e.g. laptops, e-book readers) – the days of the RF Exclusion Zone are clearly numbered.

Philip Keebler of the prestigious EPRI thinks so, anyway, and he has written two articles in In Compliance magazine about what should replace it: "Eliminating the Need for Exclusion Zones in Nuclear Power Plants, Part 1", 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, and "Part 2": 10 July

2011, www.incompliancemag.com/index.php?option=com_content&view=article&id=737:eliminating-the-need-for-exclusion-zones-in-nuclear-power-plants-part-2&catid=26:design&Itemid=130.

685) Russian Satellite Crash May Have Been Caused By EMI

A Russian Geo-IK-2 satellite launch failed "because of possible external electromagnetic interference from a sea-, land- or air-based source."

The satellite was launched by a rocket converted from a SS-19 intercontinental ballistic missile that apparently did its job sufficiently well, but an additional Briz-KM booster malfunctioned.

Finally, the Geo-IK-2 was boosted to an abnormal 370 to 1,020 km elliptical orbit. The satellite's solar batteries unfolded and contact was established, but it could not function properly.

A "reliable space industry source" told Interfax news agency that the Briz-KM booster failed during the Geo-IK-2 launch "because of possible external electromagnetic interference from a sea-, land- or air-based source" while the platform was on the other side of the globe out of sight of the Russian control center (Interfax, February 14). Of course, only the grand old enemy – the US – could have sabotaged the Geo-IK-2 launch by a presumed death-beam – to undermine Russia's possible GLONASS (GPS) independence.

(From http://www.interferencetechnology.com/lead-news/article/russian-satellite-crash-may-have-been-caused-by-emi.html, 03/09/11 02:16 PM and also from : http://politicom.moldova.org/news/russias-glonass-positioning-system-cannot-work-properly-217776-eng.html.)

686) Gym machines that throw runners off due to EMI

In a message dated 15/02/2012 10:53:16 GMT Standard Time, john-davies@emcgoggles.com writes:

I dealt with a real EMC problem where some running machines in gyms would suddenly stop unexpectedly, dangerously throwing their runners off the machines. After a bit of work I discovered that heavy and slow runners were causing fluctuations on the mains supply. This in turn would cause a glitch in the software of other machines. The software was modified to be more robust and the problem was solved.

With a mains dips and interruptions generator, I was able to replicate the fluctuations produced by a heavy, slow runner, and I caused the running belt to stop. I was also able to observe that the software fix eliminated this problem.

If I recall correctly, the software fix was related to a "watch-dog" function.

In a message dated 16/02/2012 12:32:41 GMT Standard Time, richard.marshall99@btinternet.com writes:

More specifically, John's quoted problem is almost certainly associated with the determination of the zero-crossing point of the mains voltage waveform . The timing of this is being used for timing one (victim) machine's power control and is being disturbed by a strange current waveform being drawn by the other (culprit) machine.

The problem could have been fixed in either the analogue or digital domains. The analogue solution would have involved discrete components – possibly quite large ones. The digital solution would have involved a software phase-locked loop.

Over the years I have had two clients for whom this specific problem had very serious implications!

I do not see any conflict between my views from outside and John's view from inside. In the EMC world we often have to express opinions or take actions from inadequate data.

(Taken from an email thread with the permission of John Davies of EMC Goggles Ltd, www.emcgoggles.com, and Richard Marshall of Richard Marshall Ltd, www.design-emc.co.uk, both highly experienced and independent EMC expert consultants.)

687) Urban Wi-Fi interference

British telecom regulator Ofcom has commissioned a report that concludes that Wi-Fi performance in central London can be up to four times slower than that found in less densely populated areas.

Although users of Wi-Fi have blamed nearby networks for much of the interference in the 2.4-GHz Wi-Fi band, the authors of the report pin the primary sources of interference on cautious parents using analog baby monitors, tired citizens watching retransmitted TV in their bedrooms, and microwave ovens.

The report notes that in central London, there are too many networks with resends, beacons, and housekeeping filling 90 percent of the data frames sent over Wi-Fi, thus leaving only 10 percent for users' data.

Another source of Wi-Fi trouble is caused by London's "Free Public Wi-Fi" points that are sending out beacon frames ten times more frequently than they should (every 0.01204 seconds) resulting in a significant amount of traffic on the Wi-Fi band.

Further complicating the situation is the fact that the makers of inexpensive unlicensed devices such as analog baby monitors or remote switches have no real incentive to develop more expensive digital models that cause less interference.

The entire 93-page report can be viewed online at: http://stakeholders.ofcom.org.uk/market-data-research/technology-research/research/exempt/wifi/. "Estimating the utilisation of key license-exempt bands spectrum bands", Final report, Issue 3, April 2009, for Ofcom by Mass Consultants Ltd, Cambridge, UK, systems@mass.co.uk, MC/SC0710/REP003/3, 149 pages.

(From: http://www.interferencetechnology.com/news/top-stories/single-news-article/article/urban-wifi-interference.html)

688) Vacuum cleaner upsets burglar alarm system

I have just disposed of an Orek upright vacuum cleaner which we were given as every time I used it set off the internal alarm on our burglar alarm system which could only be turned off by a full power down reset by the engineer. Normal keyboard reset codes had no eefect.

The burglar alarm system is pre EMC Directive being around 15 years old. It was cheaper to buy a new vacuum cleaner than replace the alarm system. I certainly wasn't going to pull up the floorboards to harden the system.

(Kindly sent in on 18 Oct 2007 by Nigel Carter, now retired from QinietiQ.)

Ooops – this is a repeat of #517 !!!

689) Nintendo DS Health & Safety Precautions

WARNING - Radio Frequency Interference

The Nintendo DS can emit radio waves that can affect the operation of nearby electronics, including cardiac pacemakers.

- Do not operate the Nintendo DS within 9 inches of a pacemaker while using the wireless feature.
- If you have a pacemaker or other implanted medical device, do not use the wireless feature of the Nintendo DS without first consulting your physician or the manufacturer of your medical device.
- Observe and follow all regulations and rules regarding use of wireless devices in locations such as hospitals, airports, and on board aircraft. Operation in those locations may interfere with or cause malfunctions of equipment, with resulting injuries to persons or damage to property.

(From: http://www.nintendo.com/consumer/manuals/precautions_ds_english.jsp)

690) Ferry electronics out of control

Perhaps the most serious design failing was the lack of a backup power supply for the microprocessor. Whenever the CPU shut down temporarily during a power transient, it would start up again with its memory in a random state – and the ferry would be out of control. If the captain spotted the failure, he could switch to manual control, but no alarm existed for the condition.

Starting up a motor, or even putting a quarter in a vending machine on board with a faulty ground, was enough to trigger the failure, which in some instances disengaged the propellers, and in others, randomly changed the propeller blade angles. Moving the blades to certain positions could cause the ferry to reverse direction, but usually it would simply overload the engine and shut it down.

Intermixing of system grounds contributed to the problem. In one boat, a chafed wire grounded a circuit and made it possible to change propeller pitch by starting an engine or to start an engine by changing propeller pitch. Also, although drawings called for it, no shielding for electrical noise was installed on most cables.

Poor software and hardware documentation and inexplicable differences between ferries frustrated troubleshooting, Davis said.

Installing a dc power supply for the control system and software changes eliminated some of the more embarrassing failures, but problems persisted. Even though a pneumatic control system experimentally installed on a Issaquah-class boat in 1984 reacted more slowly than the digital system the digital system and required more periodic maintenance (replacing seals, for example), a 1986 Lockheed Shipbuilding Co. study recommended switching to pneumatics to improve reliability.

The agency chose a hybrid system that operates electrically from control handles to control cabinet to improve reaction time, but operates pneumatically from cabinet to propellers and engine governors, which would last longer because of gentler treatment.

After a trial last summer on one ferry, assistant deputy director Terry McCarthy said the agency was "ecstatic" about the success of the pneumatic system supplied by Mathers Contol Inc., Seattle, and has recently retrofitted another Issaquah ferry with the same system.

(Taken from IEEE Spectrum magazine, Feb 1990.)

691) Interference onboard the Crystal Ocean

The Crystal Ocean is an oil production storage and off take vessel that is moored (without anchors) over an oil well on the sea floor, using satellite positioning along with bow, stern and centre thrusters. Crude oil is pumped from the oil well and natural gas is separated and forced back into the well. The crude oil is then pumped to the shuttle tanker Basker Spirit, moored 1.5 km away.

Located on board the Crystal Ocean are 4 large diesel driven generators which power all of the vessels electrical systems including thrusters, pumps and hydraulics. The reliable operation of these generators is critical for positioning and operation of this vessel. UHF radios are used on board to enable the crew to communicate with each other. It had been observed by crew members that when these radios were used near the AC power generators, the generators would intermittently shut down without warning. Compliance Engineering Pty Ltd was called in to investigate and resolve this interference issue.

To enable investigations to be performed without impeding the vessels operation, one of the AC power generators was removed from service. A UHF radio was operated around this generator instigating a shut down. The UHF radio appeared to have the greatest effect when operated in the vicinity of electrical cabling attached to the generator. The amplitude and direction of the UHF radios signal was not configurable, and further investigations required a repeatable method of simulating and applying the interference to individual cables.

An RF Signal Generator (with variable output level and modulation capabilities), RF Power Amplifier and RF Injection Clamp were configured to form a controlled interference generating system (500 MHz with 1 kHz modulation). The interfering signal was applied to various cables, each of which caused the generator to cease operation. However, it made little difference as to which cable the interfering signal was applied to, as all cables appeared to efficiently cross couple the RF signal. During application of the simulated interference it was observed that the generators speed gauge behaved erratically, displaying a speed inconsistent with the actual rotational speed of the generator.

The generator was immobilised and the injection clamp positioned around the speed pickup sensor cable, above the metal housing of the flywheel. An oscilloscope was used to examine the control signals within the generator's junction box (with and without the interfering signal applied) to identify signals supplied to the PLC and Load Sharing/Speed Controller, located in the control room above. With the generator immobilised and with the interfering signal applied, a 5V signal was present on the output lines from the speed pickup sensors. It was evident that the interference was inducing a false speed signal, which was processed by the PLC and Load Sharing/Speed Controller.

The interference mechanism was identified:

The UHF radios carrier frequency (500 MHz) is coupled onto unshielded cabling (directly or indirectly via cross coupling) attached to the speed pickup sensors. The speed sensors internal amplifier circuit demodulates the carrier frequency rendering the modulation signal (1 kHz in this case). The modulation signal is then amplified and fed back to the PLC and Load Sharing/Speed Controllers, which interpret the signal to be outside normal operating conditions, forcing the generator to shut down.

Cables interconnecting the vessels generators and PLC and Load Sharing/Speed Controllers are all unshielded. Transients produced by high current switching on power cables may be induced onto signal lines, causing interference issues that have not been investigated.

Recommendations to remedy the interference were presented:

Initially the unshielded cables interconnecting between the speed pickup sensors and the PLC and Load Sharing/Speed Controllers should be replaced with twisted pair shielded cables. This is expected to provide a substantial improvement to the generators immunity to RF interference. At a later stage all unshielded cabling interconnecting the generators and their controllers should be replaced with twisted pair shielded cable, with the shield terminated at both ends. The speed sensors used have plastic female push connectors, which do not allow for the cables shield to be terminated. The speed sensors should be upgraded to the FA2J version, which are fitted with a metal canon connector (14-5PN VG95234), providing a 360 degree termination for the cable shield.

It is commonly recognised that circuits which are the most prone to RF interference are typically those with sensitive analog inputs (as opposed to digital circuits), as has been observed in this example.

(Taken from: EMC Society of Australia, Newsletter, Issue 39, Dec 2007 and http://www.compeng.com.au/document_library/interference_onboard_crystal_ocean.aspx.)

692) Robot car loses GPS due to EMI from video screen

Not all went according to plan. Tartan Racing's winning vehicle refused to start, after its GPS receivers lost the signal from the satellites, and hence their ability to produce a reliable position estimate.

The problem was later traced to electro-magnetic interference from a large video screen nearby.

(Taken from: Engineering & Technology magazine, http://eandt.theiet.org, December 2007, page 11, describing a race for driverless vehicles.)

693) Cement mixer dumps load due to CB Radio interference

A cement truck complete with spinning mixer stops at an intersection. A semi, equipped with a CB radio pulls alongside and a convertible stops behind the cement truck.

While waiting for the light to change, the semi starts talking on his CB. The CB's signal activates the cement mixer, which dumps its load of wet cement into the convertible.

(Kindly sent in by Dr Antony Anderson, Dec 2007 – source: Jeff Bennett – Business writer, Detroit Free Press, 5 Dec 2002)

694) Airport navigation disrupted by domestic coffee machine

In the 1970s new domestic electronic Mr Coffee machines caused interference that disrupted the navigation systems at Baltimore and Washington DC airports and forced both airports to shut down for two hours every morning.

(Kindly sent in by Dr Antony Anderson, Dec 2007 – source: Jeff Bennett – Business writer, Detroit Free Press, 5 Dec 2002.

695) Black Hawk helicopter knocked out of the sky by radio waves

The Army's most advanced helicopter can be knocked out of the sky by routine radio waves from microwave towers, radio antennas and radars. Investigators believe that such radio waves made five of the army's UH-60 Black Hawks nose dive into the ground since 1982 killing 22 servicemen.

Navy Sea Hawks, with improved protection against electromagnetic interference, did not appear to suffer from the same problem.

(Kindly sent in by Dr Antony Anderson, Dec 2007 – source: The Boston Globe, 8 Nov 1987.)

696) Protecting valuable assets from CM currents

A typical application for the Sinus Filter Plus++ is for protecting the bearings of an underground pump motor used in a combined geothermal/solar panel heating system. The cable run from the frequency inverter to the pump is necessarily very long and the water column provides a low impedance path back to ground, which encourages current pulsing through the motor bearings. To replace or repair such a pump would also prove a very costly exercise. The filter is connected to the output terminals of the frequency inverter to reduce the damaging common-mode disturbances; the general EMC performance of the equipment is also greatly improved.

Bearing failure isn't the only problem that can be solved by applying Sinus Filter Plus++. Water abstraction bore holes are often sited in remote locations; in the middle of a forest for example, and the cable run to the pump motor is usually over a long distance. The high-frequency common-mode disturbances flow back along the path of lowest impedance, to earth through the water pipe as shown in the diagram.

One of the conditions of the abstraction license is that an accurate record is maintained of the water pumped out of the bore hole. However, the high-frequency interference causes the metering equipment to give inaccurate measurements – a problem that can be solved by fitting the REO filter.

(Taken from: DPA Magazine, 1 Feb 2008, http://www.dpaonthenet.net/article/13506/Protecting-valuable-assets.aspx)

697) Ground based air-conditioning system interfered Aircraft communication channel

Abstract—This paper describes a very unusual cause of VHF band interference and the technique for how the source of radiation was determined. An electronic circuit that controls a motor driven air intake flap of an air-conditioner heat exchanger, "mutated" into a broadband VHF transmitter, jamming a large segment of the VHF band.

I. INTRODUCTION

Pilots on aircraft NATO 1 (N1) reported multiple squelch breaks on radio VHF 5. This specific feature occurred during taxi, takeoff and landing with the radio tuned to the main operating base Geilenkirchen tower frequency of 140.075 MHz. When the VHF radio squelch opened, a very loud buzzing was heard on the headset. Furthermore, this fault was reported only intermittently by the pilots, as it did not occur on some days. Because the phenomenon could not be isolated and eliminated in an adequate time frame, aircraft commanders refused to fly N1 until the problem was solved.

II. FACT-FINDING

A spectrum analyzer (SA) connected to the dual band antenna VHF 5 of N1 (parked at spot 10) showed a broad band of spectral lines cluttering above and below the tower frequency of 140.075 MHz (see Fig. 1). A similar measurement was done on the legacy aircraft 444, which was parked on spot 9 (see Fig. 2).

III. LOCATING THE SOURCE OF INTERFERENCE

In order to avoid a possible ground loop with the SA, the external power source and the ground potential of the aircraft, a battery operated DC to AC converter was used to apply power to the SA. All aircraft power was shut down and the aircraft power cable was disconnected. The test result was virtually the same as shown in Figure 1 above. It was now clear that the defect was an externally generated VHF band-jamming signal. The signal source was pinpointed to the area inside Hangar 1 by use of a handheld VHF band radio scanner. The buzzing signal was heard at all locations inside and in front of Hangar 1 and towards the runway. Hangar 1 is located 300 meters away from the center of the runway. However the buzzing signal could be received at both ends of the runway. The length of the runway is more than 3000 meters. With

the SA, a plot was taken inside Hangar 1 (see Fig. 3). The audio output of the handheld scanner was measured with an oscilloscope (see Fig. 4 and 5) in order to determine the modulation type of the interfering signal.

IV. FINDING THE SOURCE OF INTERFERENCE

In order to confirm that the signal source was located somewhere inside Hangar 1 it was decided to completely shut down the mains power from the adjacent Building 217 and Hangar 1 on the next day. The test result is shown in Fig. 6 and 7.

During the power shut down time of Hangar 1, a plot was also taken at the VHF 5 antenna on aircraft N1. The distance between the aircraft N1 and Hangar 1 is about 200 meters (see Fig. 8).

V. TRIANGULATE THE INTERFERENCE

The challenge was now to find the actual source that generated this kind of interference. With the assistance of the StOV-German Garrison Administration's electricians and air conditioning specialists, Hangar 1 was powered down again. Power was reapplied to the Hangar in discrete sections in an effort to localize the source. The interference returned when power was applied to the air conditioning system. The air conditioning specialists attempted to isolate the subsystem that was causing the interference. While the handheld scanner was monitored, various functions were switched off and back on. The interference coincided with power being removed and restored to the motor control circuit that moves a flap inside of one of the heat exchangers mounted on the roof of Hangar 1. Heat exchanger 24 was identified as the originator and was inspected on the roof of the building (see Fig. 9)

The motor driven air intake flaps control the airflow inside each of the heat exchangers. The suspected motor assembly was removed for further investigation (see Fig. 10).

All heat exchangers mounted on the roof were inspected with the handheld scanner. The results revealed a second assembly showing similar symptoms. It was also removed for further investigation.

The bench test for the above-mentioned flap controller confirmed that the electronic motor control circuitry had “mutated” to become a broad band VHF air band transmitter when the flap reached the mechanical limit at the flap open position (see Fig. 11 and 12).

VI. TROUBLESHOOTING THE MOTOR CONTROL UNIT

It was necessary to reengineer the schematic diagram of the circuit board in order to fully understand the circuit function of the motor control unit and to isolate the failing mechanism (see Fig. 13 and 16).

VII. OBSERVATIONS

The circuit operates with 24 VAC under normal conditions. When the circuit is operated with 24 VDC instead and the clockwise motor rotation is stopped, the circuit begins to oscillate at a stable frequency of 133.5 MHz (see Fig. 14).

VIII. FUNCTIONAL DESCRIPTION OF MOTOR CONTROL CIRCUIT AND TROUBLESHOOTING

The circuit consists of a constant current source, which supplies 50 mA of current to the connected DC motor. Connecting 24 VAC between KL2 pin 1 and 2 supplies 17 VDC across the motor terminals KL1 pin 1 and 2. The current is regulated to 50 mA and causes the motor to turn in a clockwise direction. The flap moves to the upper mechanical limit, which forces the motor to stop. The resistance across the motor decreases and, due to the current regulation of the voltage across the motor, drops to 7 VDC to prevent the motor from overloading. At that moment the circuit starts to oscillate at VHF frequencies. A 50 Hz (20ms) AC ripple is riding on the bias current to the base of transistor T1, which produces a combination of pulse and amplitude modulation.

This modulation generates multiple radio frequency side bands (see Fig. 11 and 12). Connecting 24 VAC between KL2 pin 1 and 3 supplies 17 VDC with reversed polarity across the motor terminals KL1 pin 1 and 2. The motor turns counterclockwise and the flap stops at the lower mechanical limit. No oscillation occurs at this point.

Troubleshooting the circuit was difficult because probing the circuit with an oscilloscope stopped the oscillation at almost any test point. For example, oscillation stopped when the emitter of T1 was measured. C1 and C2 were therefore removed for the measuring of their capacitance. Both values were well within limits. Reinstalling the capacitors in reverse positions stopped the oscillation at both mechanical flap stops. Measuring the equivalent series resistance (ESR) values indicated the location of the problem. C1 had a twice as high ESR as C2. In addition, the circuit board layout adds some instability due to the design of the trace between T1 and R4 (see Fig. 15).

IX. RF-COUPLING PATH

The electrical control central that provides power to all motor control circuits is located in a separate room inside Hangar 1. It supplies 24 VAC motor control signals and ground to the motor control circuits on the roof of Hangar 1 via unshielded cables (30 to 50 meters long vertically mounted). Measurements were taken with an RF-current probe at the cable that was connected to the defective motor control circuit reviled, that the cable was the radiating element. This explained the large transmitting range of the oscillating circuitry.

X. CONCLUSION

Because of flight safety considerations the motor control units in all heat exchangers were replaced with a newer model.

BIOGRAPHY

Norbert Kohns was born in Weißenthurm, Germany, in 1949. For 25 years, he has been employed as a NATO civilian. Currently he serves as a Principal Technician and Maintenance Instructor of the NATO AWACS Electronic Support Measures shop, located at the NATO Airbase in Geilenkirchen, Germany.

In addition, he is the focal point of EMI/EMC related issues of the NATO E-3A fleet.

(Taken from the EMC Society Newsletter, Issue 215, Fall 2007, For the figures, see: http://www.emcs.org/acstrial/newsletters/fall07/practical_papers.pdf)

698) LORAN saved, provides backup when GPS interfered with

The Long Range Aid to Navigation (LORAN) system (originally LRN for Loomis Radio Navigation, after it's inventor, Alfred Lee Loomis) has been around for decades, with roots that go back to World War II and that era's naval warfare. Simply put, it is a terrestrial, radio-based navigation system that uses the time intervals between the reception of signals to triangulate a user's position.

The venerable system has modern value: the greater capabilities of the new enhanced Loran (eLoran) make it a much-needed independent, redundant backup to GPS, and one less susceptible to interference than GPS is.

(Taken from: GPS World, 8 Feb 2008. http://www.gpsworld.com/wireless/news/loran-saved-money-questions-remain-3849.)

699) Avoiding motor drive interference with TV filming and transmission

The fan itself sits in a plant room and is powered by a large ABB motor and a 160kW ABB low harmonic drive. This low harmonic specification is necessary to minimise interference with TV filming and transmission equipment used at all matches at the ground.

(Taken from an article about the engineering used in Arsenal's Emirates Stadium, in: The Engineer, 11-24 Feb 2008. http://www.theengineer.co.uk/news/gunning-for-perfection/304509.article.)

700) Quantum Consciousness and Energy Medicine

Energy-related practices have been around for many thousands of years within indigenous tribes and various cultures. 'Life as Energy' has even been a construct in our Western minds for millennia, but in the last century it has congealed as science through quantum physics. This advanced physics model reveals that we are electromagnetic fields. In the 21st century, quantum medicine is being applied for self-healing, and the possibilities are limitless.

We have yet to utilize these constructs fully, but we are slowly catching on. We know, for example, that there are energy frequencies which are harmful to us, like living under high power wires and being too close to TVs, computers and cell phones. We also know that some energy frequencies are helpful. Energy frequencies can be quite powerful tools for healing.

$E = mc^2$

'Ninety-nine percent of who you are is invisible and untouchable.' (R. Buckminster Fuller)

Einstein's physics presented us with the knowledge that everything in the universe is the energy of light. Matter is simply frozen light. We are not bodies with an energy field surrounding us, but expansive electromagnetic fields of light within which a small part of us vibrates at a visible frequency.

Within this vast field, there is a blueprint that holds the "tensegrity" or tensile structure of our Being together - from cells to cosmos. This set of interacting mathematical and geometric shapes is called our sacred geometry. Quantum age energy medicine affects all levels of our electromagnetic fields - subatomic, cellular, physical, subtle, and spatial, including our geometric blueprint, the life force itself and beyond. It is able to do that merely by holding an expanded awareness.

(Taken from a webpage by Virginia Leslie, MA: http://home.mindspring.com/~kiva4/id4.html.)

(We always celebrate each 100th Banana Skin with something a little humorous – but perhaps we should be more sensitive, and say: something from outside the world of Electromagnetic Compatibility engineering!)

701) Snooping through the power socket

Power sockets can be used to eavesdrop on what people type on a computer. Security researchers found that poor shielding on some keyboard cables means useful data can be leaked about each character typed.

By analysing the information leaking onto power circuits, the researchers could see what a target was typing. The attack has been demonstrated to work at a distance of up to 15m, but refinement may mean it could work over much longer distances.

Hotel attack: 'Our goal is to show that information leaks in the most unexpected ways and can be retrieved," wrote Andrea Barisani and Daniele Bianco, of security firm Inverse Path, in a paper describing their work.

The research focused on the cables used to connect PS/2 keyboards to desktop PCs. Usefully, said the pair, the six wires inside a PS/2 cable are typically "close to each other and poorly shielded". This means that information travelling along the data wire, when a key is pressed, leaks onto the earth wire in the same cable. The earth wire, via the PC's power unit, ultimately connects to the plug in the power socket, and from there information leaks out onto the circuit supplying electricity to a room.

Even better, said the researchers, data travels along PS/2 cables one bit at a time and uses a clock speed far lower than any other PC component. Both these qualities make it easy to pick out voltage changes caused by key presses.

A digital oscilloscope was used to gather data about voltage changes on a power line and filters were used to remove those caused by anything other than the keyboard.

"The PS/2 signal square wave is preserved with good quality... and can be decoded back to the original keystroke information," wrote the pair in a paper describing their work. They demonstrated it working over distances of 1, 5, 10 and 15m from a target, far enough to suggest it could work in a hotel or office.

"The tests performed in the laboratory represent a worst case scenario for this type of measurement, which along with acceptable results emphasizes the feasibility of the attack on normal conditions," they added. The pair said their research was "work in progress" and expect the equipment to get more sensitive as it is refined. The attack is due to be demonstrated at the Black Hat conference that takes place in Las Vegas from 25-30 July.

(Taken from: BBC News 13 July 2009. http://news.bbc.co.uk/1/hi/technology/8147534.stm)

702) In-flight calls still on hold

As the summer holiday season begins, the UK Civil Aviation Authority (CAA) is reminding air passengers that using mobile phones is still forbidden on nearly all flights.

Although some airlines have introduced 'mobile phone systems' on a number of their aircraft, the use of mobile phones generally remains prohibited on the majority of aircraft.

Passengers who find themselves on board an aircraft modified to allow mobile phone use will be informed by the cabin crew and given instructions on how and where their phone can be used.

Any passenger who disobeys a cabin crew instruction to turn off a mobile phone is committing an offence, which could result in prosecution.

Research carried out by the CAA found that the use of mobile telephones can adversely affect navigation and communication functions, producing significant errors on instrument displays and background noise on pilot radios. The research endorses evidence from pilots, who have complained that interference from mobiles has caused:

- False notification of unsafe conditions, e.g. false baggage compartment smoke alarm warnings;
- Malfunction of aircraft systems;
- Interrupted communications due to noise in the flight crew headphones; and
- Distraction of crews from their normal duties due to increased work levels and the possibility of having to invoke emergency drills.

Bob Jones, Head of Flight Operations at the CAA, said: "The safety risks of using a mobile on board an aircraft are well-established. Yes, some airlines are currently testing various systems, but this does not weaken in any way the ban on phones being used on board the vast majority of UK aircraft."

"Unless specifically told otherwise, passengers must not text or phone while the cabin doors of an aircraft are closed. Safety is the number one concern of the aviation industry, therefore mobile phones will remain banned until the technology that allows their safe use is installed."

Notes to Editors:

- BMI, Ryanair, Air France, TAP Portugal, Qantas, Emirates and British Airways are among the airlines currently using or planning to trial on-board mobile phone systems on some aircraft. These trials are being closely monitored by the relevant aviation safety regulators.
- Some other airlines allow the use of mobile phones on-board if they can be put in 'flight mode', which disables any calls and texts. However, like any electronic device, these should still be turned off for take-off and landing and when instructed.
- Detailed research on the effects of mobile phones on aircraft electronic systems carried out by the CAA can be found at http://www.caa.co.uk/docs/33/capap2003_03.pdf
- The CAA is the UK's specialist aviation regulator. Its activities include: making sure that the aviation industry meets the highest technical and operational safety standards; preventing holidaymakers from being stranded abroad or losing money because of tour operator insolvency; planning and regulating all UK airspace; and regulating airports, air traffic services and airlines and providing advice on aviation policy from an economic standpoint.

(Taken from the CAA report dated 16 June 2009: http://www.caa.co.uk/application.aspx?catid=14&pagetype=65&appid=7&newstype=n&mode=detail&nid=1776)

703) Could Smart Technology Imperil the Power Grid?

Advanced electrical meters and other smart grid devices may help cut electricity consumption in homes and businesses, but some are worried this technology may also make the nation's power network more vulnerable to attack.

Experts are warning that the government will step in unless the power industry protects itself from certain threats, such as a major solar storm that triggers an electromagnetic pulse in the atmosphere, disabling all satellite, radio and telephone communications and causing nationwide power blackouts.

From: Interference Technology, 4/6/2012, http://72.29.76.194/~interfer/could-smart-technology-imperil-power-grid. Visit the Mother Nature Network to learn more. http://www.mnn.com/earth-matters/politics/stories/smart-technology-may-increase-grids-vulnerability)

704) House Subcommittee Cautions on EMP and Cyber-Attacks

On Tuesday, July 21, 2009, a subcommittee of the U.S. House of Representatives' Committee on Homeland Security heard testimony about the nation's vulnerability to an EMP (electromagnetic pulse) attack or a cyber-attack on power grids.

The Subcommittee on Emerging Threats, Cybersecurity, and Science and Technology heard from witnesses drawn from both industry and government about precautions, or lack thereof, for protecting the U.S. infrastructure from the massive interference and disruption that would result from detonating an atomic device causing a burst of radiation (EMP) or from an attack launched by "hackers" to paralyze modern life and commerce by compromising the computer-based controls of electric power suppliers—events that could disrupt commerce, communications, and all the conveniences that are the underpinnings of modern life.

Both subcommittee chair Yvette Clarke (D, NY) and Homeland Security chair Benny G. Thompson (D, MS) gave sobering reports on the current state of preparedness. Rep. Clarke indicated that after a three-year study, the members had reached one conclusion. "The electric industry has failed to appropriately protect against the threats we face in the 21st Century."

Rep. Thompson noted, "There is a massive computer espionage campaign being launched against the United States by our adversaries. Intelligence suggests that countries seek or have developed weapons capable of destroying our grid." Find the complete list of witnesses and a video transcript of the hearing on the Committee website.

(From: Interference Technology, 4/6/2012, http://72.29.76.194/~interfer/house-subcommittee-cautions-on-emp-and-cyber-attacks)

705) Examples of incompatibility with EE&CS limits from testing

Careful study and analysis of conducted train emissions can give a lot of information about the train's compatibility or otherwise with EE&CS limits. Some examples are given here where there were incompatibilities identified from train testing for a variety of track circuit types operating at various frequencies. These examples are all from outside of the UK.

Figure 3 is an interesting example of the noise measured across an FS2500 track circuit intermediate receiver when three different forms of traction technology trains passed over the receiver. The FS2500 track circuit is an FSK coded track circuit operating at one of four centre frequencies, 1700Hz, 2000Hz, 2300Hz and 2600Hz. Lock up of the receivers were experienced, due to passage of 3 phase drive traction trains over the receiver. Due to the coding of this type of track circuit, WSF is unlikely and the problem in this case was RSF of the track circuits. This did however cause serious service disruption requiring technician call out to reset the receivers in the event of the lock ups occurring.

The first trace was for a conventional camshaft technology train. This type of train was the mainstay of traction control before the advent power electronics technologies. In essence the DC traction motor voltage is controlled by switching in and out resistors. There are no characteristic operating frequencies. The DC supply voltage is connected across the motors and the resistors which are progressively switched out to increase the voltage across the motors themselves. The control is actually more complex than this - with parallel series reconnection of the motors and weak field operation; however it is the switching events that are the most significant in terms of harmonic emissions. Their interference waveform is characterised by low level broadband noise associated with switching transients. This noise was picked up by the 1700Hz receiver and seen as voltage peaking at 1.5mV.

The second trace was for a chopper controlled train. This technology still utilises DC traction motors but Gate Turn Off (GTO) thyristor power semiconductors are used to switch (or chop) the DC voltage on and off, thus varying the net DC voltage applied to the motors. A fixed chopping frequency is used (or a number of fixed frequencies) and this results in a characteristic high level emission at the chopping frequency. Their interference waveform is similar to conventional camshaft traction (low level broadband noise) with the addition of specific harmonics related to the fixed chopping frequency, seen in the second trace as a peak of 11mV at approximately 1570Hz. Whilst the peak is relatively high at 1570Hz, this characteristic is known and it is possible to choose the chopping frequency to specifically avoid any known signalling frequencies.

The third trace was for a 3 phase drive technology train utilising IGBT (Insulated Gate Bipolar Transistor) inverters to control AC traction motors. In contrast to DC traction motors whose speed are controlled by the voltage applied to them, AC traction motor speed is controlled by varying the frequency and the voltage applied to them. The inverter fundamental frequencies vary between about 50Hz to 594Hz and at harmonics of these frequencies, therefore sweeping right through the FS2500 frequency band. The level measured was up to 10mV right through the 1700Hz receiver band and was the cause of the periodic lock ups of the receiver.

The solution to the problem was either to reduce the train emissions, which is always difficult if the train is already in service, or to reduce the susceptibility of the receivers. It is pointed out at this point that it is perfectly possible to design a 3 phase drive train to meet susceptibility requirements for FS2500 track circuits. The problem was a combination of the IGBT switching pattern not optimised to minimise harmonics in the 1700Hz band combined with poor bonding arrangements. In addition to this the FS2500 intermediate receivers were of a poor design being susceptible to common mode rail currents whereas the parent receiver is not.

This demonstrates the importance of good design from the earliest point in the project to avoid problems only being discovered on the track. In this particular case modifications were made to the infrastructure (the intermediate receivers) this being simpler and less costly than train modifications.

(Taken from: 'Traction Compatibility with EE & CS Infrastructure' by Adrian Hines of Railway Technology Consultants Ltd, a paper he presented at EMC-UK 2008, Newbury.)

706) RFID can interfere with medical systems

Context. Health care applications of autoidentification technologies, such as radio frequency identification (RFID), have been proposed to improve patient safety and also the tracking and tracing of medical equipment. However, electromagnetic interference (EMI) by RFID on medical devices has never been reported.

Objective. To assess and classify incidents of EMI by RFID on critical care equipment.

Design and Setting Without a patient being connected, EMI by 2 RFID systems (active 125 kHz and passive 868 MHz) was assessed under controlled conditions during May 2006, in the proximity of 41 medical devices (in 17 categories, 22 different manufacturers) at the Academic Medical Centre, University of Amsterdam, Amsterdam, the Netherlands. Assessment took place according to an international test protocol. Incidents of EMI were classified according to a critical care adverse events scale as hazardous, significant, or light.

Results. 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; 63%) compared with the active 125-kHz RFID signal (8 incidents in 41 EMI tests; 20%); difference 44% (95% confidence interval, 27%-53%; P < .001). The passive 868-MHz RFID signal induced EMI in 26 medical devices, including 8 that were also affected by the active 125-kHz RFID signal (26 in 41 devices; 63%). The median distance between the RFID reader and the medical device in all EMI incidents was 30 cm (range, 0.1-600 cm).

Conclusions. In a controlled nonclinical setting, RFID induced potentially hazardous incidents in medical devices. Implementation of RFID in the critical care environment should require on-site EMI tests and updates of international standards. *(This is the abstract of the paper 'Caring for the Critically Ill Patient', by R van der Togt, E J van Lieshout, R Hensbroek, E Beinat, J M Binnekade and P J M Bakker, in JAMA, 2008;299(24):2884-2890. doi: 10.1001/jama.299.24.2884, free download from http://jama.ama-assn.org/content/299/24/2884.full.)*

707) It's the hardware. No, the software. No, it's ESD!

The author's experiences that have connected fab problems with ESD events:

- Wafer transfer robots that stop or drop wafers
- Shutdowns of diffusion furnaces
- A wafer fab experiencing so many lockups that its software-engineering staff could not keep up with its work load
- Track system lockups
- Stepper alignment errors and lockups

A manufacturer of microprocessors was experiencing random equipment problems with one of nine steppers, which commanded the attention of in-house engineers and the equipment manufacturer's field service engineers for almost six months. Software upgrades and major components were replaced without finding a solution. Measurements with a 500MHz digitising oscilloscope finally detected a spurious signal on the power supply line of the stepper that had not been seen with lower-bandwidth test equipment. The random nature of the signal finally pointed to EMI as the possible cause of the problem.

Using an electrostatic measurement tool to determine the presence of static charge located the cause of the problem in less than an hour. The factory static control program specified using static dissipative wall panels to avoid the presence of charged insulators, but one of the wall panels above the stepper was not connected to ground. When charged, this large isolated conductor discharged to the nearby grounded wall framing. The conducted EMI from the ESD event was causing the equipment interrupts.

Our experiences have revealed other scenarios where EMI was causing process equipment problems (other examples are listed in the table):

• In several facilities, tool problems were related to discharges from ungrounded ceiling panels that were supported by a grounded ceiling grid. Signals were radiating from ESD events at the corners of the panels and were conducted through power lines to overhead lighting to the circuit breaker box and then out to the tool being affected. This conduction path was a serious problem because the signal could be transmitted over a large distance without the 1/r2 attenuation that is characteristic of transmitted EMI. In one case, the tool was a wafer prober and it was reporting calibration failures. The problem was located with a DSO and a wideband antenna test set. Grounding the ceiling panels eliminated the tool problem.

• In a 2000 ft^2 photolithography area, four steppers were experiencing unexplained lockups, one a number of times each day, the others randomly. Measurements with an EMI locator indicated signals throughout the room, particularly near the ceiling channels. Not surprisingly, the highest-level signals were found in the vicinity of the stepper experiencing the most frequent lockups. Checking the equipment grounding revealed a top cover panel that was not attached, but rather rested on the top of the equipment, and was very close to one of the ceiling-mounted air ionizers. When this panel was removed, all the EMI signals in the room disappeared and there were no further lockups in any of the steppers. It was apparent that the ungrounded panel was being charged by the nearby ionizer, and was then discharging to the grounded frame of the stepper near the ceiling. This ESD event signal was picked up and conducted around the room by the ceiling channel (Fig. 2).

• There are many instances where conductive parts of wet benches are isolated from ground by attaching them to insulating materials. Inevitably these conductors become charged triboelectrically due to contact with other materials. Once charged, they will discharge the next time another conductor contacts them. The result is random lockups of the wet bench control electronics.

• A reticle inspection unit was locking up approximately five times per week. It was theorized that when reticles or reticle pods come into the tool highly charged, ESD events are inevitable. Under the assumption that the unexplained lockups were ESD-related, an ionizing bar was installed in the load/unload station of the tool. Since the reticles and pods are both composed of excellent insulators (plastic and quartz), grounding them will not eliminate charge, Charge neutralization with ionizers is the only option. When the rate of lockup with and without the addition of ionization was analyzed, it revealed a 50% reducution with the latter (Fig. 3). To investigate the origin of the residual lockups, ionization was placed on the ceiling of the room in the vicinity of the inspection station. This resulted in a second 50% reduction in the lockup rate. This indicates that ESD events even in the adjacent area tools were also causing the tool under investigation to lock up. Owing to the large distance from the adjacent tools to the one experiencing the lockups (~4m), the EMI path was almost certainly conducted.

• A wafer-transfer tool was locking up frequently. It was determined that the wafer cassette loaded into the tool came from a spin-rinser-drier. The cleaning process in this tool resulted in wafers and Teflon cassettes charged to over 20kV. Placing the cassettes on a work-in-progress rack under an ionizing bar for 120sec before putting them into the transfer tool eliminated the lockups.

Conclusion

Equipment lockups will continue to occur despite the best efforts of the software and hardware designers to anticipate the complexity of the semiconductor-manufacturing process. With increasing frequency, however, equipment interrupts are coming from other sources, such as EMI due to ESD. Many equipment failures are the result of random ESD events and a great deal of production and engineering time is wasted pursuing phantom software problems.

(Taken from the article with a similar title by Arnold Steinman and Lawrence B Levit, of Ion Systems Inc., Berkeley, California, published in a Supplement publication to Solid State Technology, May 1999. For many more articles and papers on ESD and other issue in semiconductor manufacture by Lawrence B Levit, visit http://www.lblscientific.com/publications.html.)

708) Error message! How mobile phones distort measurements

The awareness that the interference resistance of measuring systems is very dependent on the configuration and the installation on site has not been sufficiently taken into account in the normative requirements.

This discrepancy is based on the fact that the European testing requirements worked out several years ago do not sufficiently take into account the actual present-day disturbance source situation due to the spread of radio receivers and mobile phones.

Due to this technical requirement and also the possible political consequences, a revision of the respective standards was initiated in which PTB is participating.

For the determination of new normative limiting values and for the assessment of the interference resistance of measuring devices on site by the verification authorities, metrologically traceable EMC tests on site are necessary, for which there has not been a measuring device available up to now.

(Taken from: PTB (Physikalisch-Technische Bundesanstalt), 17 September 2008. www.ptb.de/en/aktuelles/archiv/presseinfos/pi2008/pitext/pi080917.html)

709) How cellphones can interfere with low-frequency electronics such as ECGs

EMI or RFI sources continue to become more prevalent in our world. This type of noise can invade even the low frequency analog circuits. The source of this radiated noise interference can be found wherever electric or magnetic fields exist.

The proliferation of intentional and unintentional EMI radiators can wreak havoc on your circuits. The signals from these radiators are not out to contaminate your circuits, but you may want to keep your low-noise systems out of harm's way. Imagine a doctor using an ECG (electrocardiogram) diagnostic tool to get a good look at your heart. This high precision measurement is also low-frequency, so the electronics don't extend past 1MHz. However, if you are connected to an ECG tool with a poor EMI design and your physician answers his cell phone during the test, you may have cause for concern.

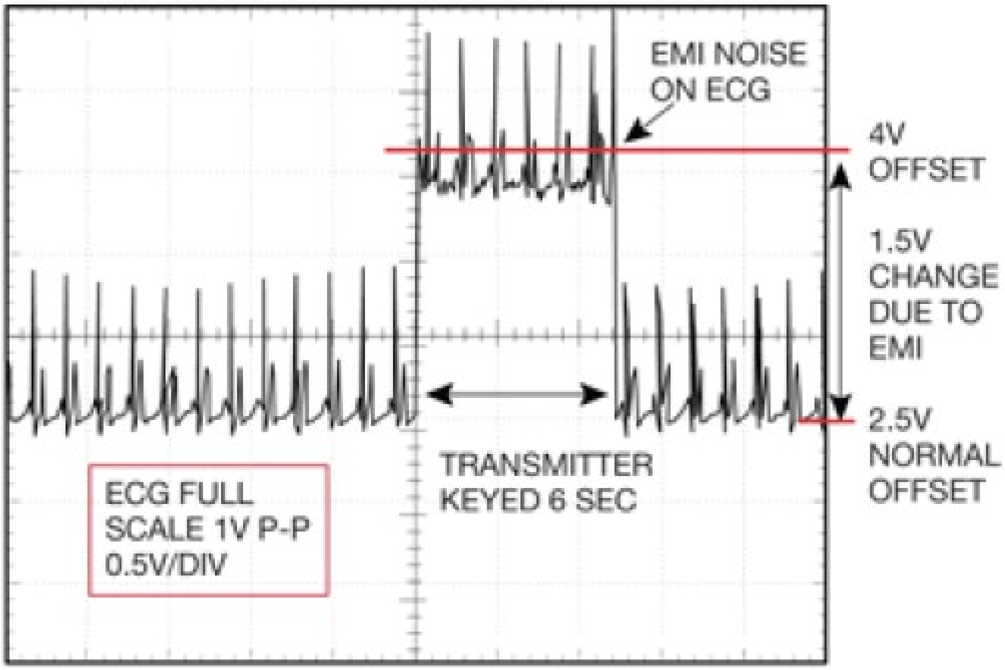


Figure 1 EMI from a cell phone can cause a 1.5V change from normal on an ECG. The ECG diagnostic tool senses a heart while a 0.5W, 470MHz transmitter turns on and off just one and a half feet away.

Figure 2 An engineer's precision, low-level ECG cardiotachometer board took the measurements for Figure 1.

The heart's input signal to the system is approximately 0.25 mV p-p. This small signal requires an instrumentation amplifier's gain of approximately 6000V/V. The good news is that the results in Figure 1 do not represent the performance of a doctor's office ECG-measurement tool. This measurement was actually taken in an engineer's lab from the board in Figure 2.

Don't fall into this EMI trap. Take care to create boards and use components that are EMI-resilient, regardless of your analog or digital circuit's bandwidth. When an EMI source is present in the vicinity of your application circuit, it may create a response to the radiating source.

How did the radiated noise from the phone get into the measurement with such a low-frequency board? In EMI terms, three elements are at work with this type of problem: a radiation source, a coupling path for the radiation signal to travel through, and a receptor. The radiation source in this example is the cell phone. The EMI signals may come through the air or be conducted across your PCB and originate from unexpected sources. EMI, or RFI, surrounds a receptor either by direct conduction or through fields. These fields couple directly into the circuit's connecting wires and PCB traces, where they are converted to conducted RFI.

Acknowledgment: Special thanks to John Brown for the ECG board and data.

(Taken from: "EMI problems? Just the facts, please", by Bonnie Baker, in EDN, February 16, 2012, www.edn.com/article/520893-EMI_problems_Just_the_facts_please.php?cid=NL_UBM+Electronics. Editor's note: Unfortunately, Ms Baker doesn't mention how it can happen that RFI at frequencies very much higher than a circuit's operating bandwidth, can result in signal errors within its bandwidth. The reason is demodulation in the non-linearities naturally present in the PN junctions in the circuit's semiconductors – the very same principle that has been used for over 100 years now to receive radio, TV and radar signals. Essentially, every low-frequency analogue circuit can be regarded as a number of radio receivers connected to PCB traces and cables that act as antennas for the local E and H fields.)

710) Uncontrolled Acceleration of Light Vehicle when 2-Way Radio was used

Mine Type: All Mine Types.

Incident: A recently introduced 4 x 4 vehicle accelerated when the button on the vehicle's 2-way radio was depressed. This was subsequently repeated several times and confirmed the incident.

While using the radio to transmit at the same time as the vehicle was engine braking down a slope, the vehicle slowed still further.

Again, after using the radio several times to transmit, the vehicle emergency engine management mode automatically initiated, resulting in a top speed of approximately 15 kph.

Queensland Government
Natural Resources and Mines

Equipment: Equipment involved included both the fitted VHF mine compliant radio and a hand held radio.

Hazard: A light vehicle exhibited uncontrolled movements while the onboard 2-way radio was being used.

Cause: Preliminary investigations have been conducted by the vehicle sales technical services manager. The problem appears to be related to electromagnetic interference with the electronic throttle positioning sensor. Similar issues have been found on certain aftermarket cruise control components.

Comments: Additional information will be released as it becomes available during the investigation.

Recommendations: All mine sites should audit their vehicle fleets to determine if the problem exists, and if so, formulate procedures to reduce the risk to an acceptable level.

Chris Skelding, Manager, Safety and Health – Central

Contact: Kevin Clough, District Inspector of Mines, +61 7 4967 0869

Please ensure all relevant people in your organisation receive a copy of this Safety alert. Any such advice supplied to site should reach those who require it, and it should also be placed on the mine notice boards.

See more Safety alerts and Safety bulletins at http://mines.industry.qld.gov.au/mining/safety-alerts-bulletins.htm *(Editor's note: this is the latest URL, 9 July 2012, not the one originally used)*.

(This is a copy of Mines Inspectorate Safety Alert 213, "Uncontrolled Acceleration of Light Vehicle when 2-Way Radio was used", originally published 28 November 2008, by the Queensland government, Australia www.dme.qld.gov.au, kindly sent in on the 30th May 2012 by our regular contributor Chris Zombolas of EMC Technology Pty Ltd, www.emctech.com.au.)

711) RFID frequently interferes with other medical technologies

Regardless of the foregoing arguments about RFID as supportive or disruptive innovation in various applications in healthcare settings, there is one consideration that opens up the possibility for new entrants to introduce disruptive innovation. Current RFID technology frequently interferes with other medical technologies.

A 2008 study conducted in The Netherlands was the first to consider the problem of electromagnetic interference by RFID tags on other medical devices [47]. After testing 2 different RFID systems against 41 different medical devices, the researchers found 34 incidents of interference in 123 tests.

Despite limitations inherent in the study, the U. S. Food and Drug Administration, manufacturers, and healthcare providers are investigating the problem further [9]….

[9] DiConsiglio, John, 2008. "Much ado about RFID", Materials Management in Health Care 17:11, pp. 28-30, www.matmanmag.com/matmanmag_app/jsp/articledisplay.jsp?dcrpath=MATMANMAG/Article/data/11NOV2008/0811MMH_FEA_Technology&domain=MATMANMAG

[47] van der Togt, Remko, Erik Jan van Lieshout, Reinout Hensbrock, E. Beinat, J. M. Binnekade, and P. J. M. Bakker, 2008. "Electromagnetic Interference From Radio Frequency Identification Inducing Potentially Hazardous Incidents in Critical Care Medical Equipment", JAMA: Journal of the American Medical Association 299, pp. 2884-2890, www.ncbi.nlm.nih.gov/pubmed/18577733)

(Taken from pages 171-2 of "RFID Technology as Sustaining or Disruptive Innovation: Applications in the Healthcare Industry" by Karen Crooker, Dirk Baldwin and Suresh Chalasani, in the European Journal of Scientific Research, ISSN 1450-216X Vol.37 No.1 (2009), pp.160-178, www.eurojournals.com/ejsr.htm. Editor's note: In their document: "The Importance of Using Wireless Engineers Who Understand Patient Care and RFID Technology", www.infologix.com/pdf/infologix-rfid-jama-response.pdfInfologix rubbished [47] claiming, amongst other things, that it took no consideration of the way wireless devices are used in healthcare premises. However, I have to say that their arguments do not take into account reasonably foreseeable misuse, as required by IEC 61508 and its many 'daughter' standards, and (more specifically) as required by Clause 4 of ISO 14971 "Medical devices — Application of risk management to medical devices". Their arguments also do not take into account the very rapidly increasing use of medical devices outside of the traditional healthcare premises, for instance: at work; shopping; travelling, etc., where RFID devices are increasingly likely to be used by people who are not medically trained and who are probably also unaware of the possibility that medical devices may be in close proximity.)

712) First Product Completes Medical Device RFID Susceptibility Testing

MET Labs has completed testing on the first product to be submitted to the Medical Device RFID Susceptibility Program. The Program – co-developed by MET Labs and the U.S. Food and Drug Administration (FDA) under the auspices of AIM Healthcare Initiative (HCI) – is designed to determine potential adverse events of radio frequency identification (RFID) emissions on electronic medical devices.

The patient-worn battery-operated vital sign monitoring device was tested at MET's Santa Clara, California laboratory. It passed six of seven tests, demonstrating a hard fault when subjected to 860-960 MHz frequency RFID at 54 V/m, as specified in ISO/IEC 18000-6 Type C. Testing was performed with the RF parameters that emit the minimum and maximum occupied band-width. The testing ranged from 134.2 kHz at 160 A/m to 2.45 GHz at 54 V/m.

Interested medical device manufacturers that have not expressed interest in the past are still eligible for participation in the program. For more information about MET Laboratories, please visit www.METLabs.com.

(Taken from Business News, on page 64 of IN Compliance magazine, April 2012, http://www.incompliancemag.com/DigEd/inc1204/offline/download.pdf)

713) Fears of TV interference from 4G cellphone roll-out

Thousands of television viewers in Shropshire could suffer problems with their digital reception if the Government pushes through plans for a more hi-tech mobile phone network, Freeview bosses have warned.

According to the company, an estimated 202,218 homes in the Central region, which includes Shropshire, could be at risk of interference with their viewing from the planned new 4G mobile phone network.

Ofcom is proposing that 4G coverage should be rolled out to cover at least 98 per cent of the population to deal with increased demand as smartphone and mobile data broadband use continues to rise. But Freeview bosses claim that the new network could lead to ‘deterioration of signal, a loss of channels, or blank screens’ for viewers.

The company, the UK’s biggest digital TV provider, has warned that Government plans to set up a £180 million fund to help counter the effects does not go far enough. Officials said that based on figures calculated by Deloitte for the Ofcom consultation, industry estimates put the total cost of providing and installing filters to mitigate interference on main and second sets at almost double the amount.

The company is now asking for the Government to revise its plans for the rollout so that mobile operators are responsible for the full costs associated with protecting television services.

Ilse Howling, managing director of Freeview, said: “We strongly believe that Freeview homes in the Midlands should not be subject to further inconvenience and additional cost to make way for mobile broadband. The Government has committed to recouping the cost of protecting viewers from interference, using proceeds from the 4G mobile auction. However, this will still leave viewers to bear a substantial proportion of the cost.

(From: www.shropshirestar.com/news/2012/06/14/fears-new-phones-network-will-hit-shropshire-tv-reception, Thursday 14th June 2012, 10:59AM BST. Also see a similar story about TVI from the 4G roll-out in the Westcountry: www.thisiscornwall.co.uk/New-phone-networks-hit-TV-reception/story-16446342-detail/story.html.)

714) CFL lamps interfere with broadcasting receivers

The Crosstalk America broadcast as a phone-in current-affairs show, often hosted by veteran broadcaster Vic Eliason, now in his mid seventies. It is produced in the main studio complex of the VCY America network, in Milwaukee, Wisconsin. On 3rd February 2012, Vic digressed while talking to studio guest Larry Pratt.

Vic – “Now we have an interesting story here. Here at the studios yesterday we had a test done.” Vic explained that this was due to new regulations requiring energy-efficient lighting to replace the old fluorescent fittings.

“And so we found out that to re-do our building here, and our broadcast buildings, would be in excess of $38,000. Over 400 light fixtures here in this one building. Well, at any rate, what came out of this is that we said, "Well, bring in a test unit." And they brought in this test unit, and we – in that studio - turned on a receiver that would be used in the field of news-gathering, and found that 21 places on the dial were being obscured by the fixtures, by the r.f. signal that was going out, literally interfering with our ability to use a news-gathering radio.”

Vic – “If we have 400 light fixtures, that's 800 of those little transmitters in a building that is sensitive to broadcast equipment. And you can't do it.”

After a comment from Larry about having stockpiled the old-style lamps, Vic joked about lighting for the studios which would not cause interference. “Well, I think we're going to go out and get some kerosene lanterns. I did my homework in high-school up to eleventh grade in kerosene lights. So we may be running our studios with kerosene lights.”

(Kindly sent in by our regular contributor Robert Higginson, on 11 Feb 2012)

715) LED Lighting tested with MIL STD 461F to prevent MRI Scanner EMI

Incandescent Lighting: A Solution Based On Compromise

Since AC-powered luminaires and dimming systems are known to generate Electromagnetic Interference (EMI), DC-powered, fixed-output incandescent luminaires became the lighting systems of preference within magnetic resonance imaging (MRI) suites.

Although this is an effective technique for mitigating EMI, it negatively impacts such important factors as power consumption, lumen output, lamp life and occurrences of sudden lamp failure – all of which increase both operation and maintenance costs and the MRI's operational downtime. In addition, the use of fixed-output severely restricts staff control of illumination levels.

LED Lighting: The Superior Alternative

Today's solid-state, DC-powered LED sources solve the EMI issues that make fluorescent lamps unsuitable for MRI area use. Recent advances in LED technology make this source a superior alternative to incandescent lamps as well. When compared to a typical150-watt incandescent installation with a 750-hour rated lamp life, white LED systems average 50,000 hours – or 66 times – more life than incandescents.

LEDs even exceed the rated life of both compact and most linear fluorescents. LEDs are also far more energy efficient than incandescents and gradually lose their efficacy (unlike heated-filament counterparts) preventing the interruption of MRI usage for lamp replacement.

Finally, Kenall's LED fixtures are dimmable, giving the MRI suite technicians the ability to tailor illumination levels to both preference and the specific function being performed at any given time.

EMI Transmission

One of the most problematic areas of lighting MRI suites has historically been EMI.

Not only are MRI systems highly sensitive to EMI emissions from lighting fixtures and other electrical devices, MRI scanners themselves emit RF pulses that can negatively affect the operational performance of lighting equipment and the lifespan of certain light sources.

When EMI from light fixtures, AC voltage, or dimming systems is present, it can adversely affect the performance of the MRI system, rendering its output unusable.

On the other hand, when the MRI scanner emits its own RF pulses they can create EMI that defeats the operational integrity of traditional light sources by causing unwanted lamp flicker and premature source burnout.

It is for reasons such as these that fluorescent sources and AC power are rarely installed in MRI suites, having been replaced in most cases by low voltage DC incandescent. While this change by itself has been successful in mitigating some EMI related issues, it has not solved all problems. In order to achieve an appropriately lit MRI environment free of problematic EMI, all potential sources of interference must be either successfully controlled or eliminated altogether.

Dimming

Dimming is an important feature for both operational safety and patient comfort in MRI suites. When scanning is performed, low light levels are appropriate as they create a more relaxed and comfortable ambience for patients. Conversely, higher light levels are needed for maintenance and other staff functions. Despite this need, even DC-powered dimming is often omitted from MRI suites due to potential EMI issues caused by voltage changes, as well as lamp flicker caused by MRI-originated EMI.

Kenall engineers have successfully solved these problems by designing and integrating special shielding systems inside the luminaires, allowing a problem-free, 0-10 volt full-range dimming capability on any system such as the Lutron Graphik Eye®, or other scene controllers, when installed per our instructions.

RFI Susceptibility and Compatibility

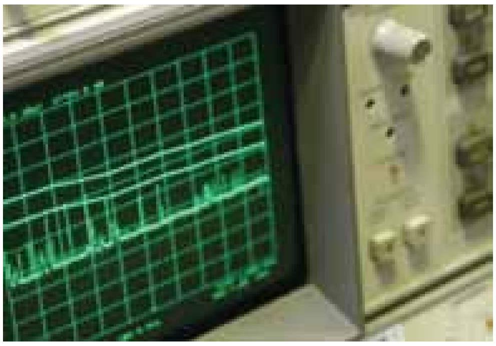
Unlike the European Community (EC), the U.S. has no government standards for RF compatibility between MRI systems and other electrical devices, nor do we have government-based programs for testing the susceptibility of one device to the RF of another. It is therefore up to the lighting manufacturer to determine the RFI potential between the luminaires and the MRI system being used. Not only must the effect of the luminaire(s) on the MRI be identified, the effect of the MRI's RF transmissions on the lighting systems must be identified as well.

To minimize the luminaire's potential effect on the MRI and vice-versa, the first step is to shield the fixture's interior to keep potential RF from escaping while also preventing the MRI's RF from affecting the luminaire. Step two is to pragmatically determine how the MRI and luminaire perform together.

Only with the combination of expert design and empirical knowledge can the specifier and user be assured of compatibility between the devices. Kenall MRI fixtures not only have the most effective shielding developed to date, they've been field-verified as compatible with systems from the world's foremost MRI systems manufacturers.

EMI Test Procedure: MIL-STD-461F NSF

To ensure Kenall luminaires for MRI/imaging suites are not producing EMI emission levels that could jeopardize the integrity of MRI images, refer to MIL STD-461F as a guideline, specifically RE102. RE102 is a radiated emissions test that covers the frequency ranges of interest. The RE102 test procedure is also suited for this application due to the set-up commonality it shares with existing MRI rooms. The test measures emissions one meter away from the luminaire in units of dB microvolts per meter.



Immunity/Susceptibility:

Another consideration is the immunity or susceptibility of a device. Ensuring our luminaires do not interfere with the MRI is part of the objective. MRI scanners put out emissions that exceed 200 V/m, which can couple onto power and control lines and can interfere with the DC supply current energizing the LED light source. The sensation the human eye experiences when this happens is commonly known as flicker. To eliminate this potential situation, it is imperative that the lighting system and installation be configured to avoid harmful absorption and transmission of electrical pulses.

How we protect our product:

Assuming the system is properly designed and installation instructions are followed, the only path MRI scanner emissions have left to penetrate is through the luminaire itself. The first line of defense is the integrity and construction of the housing; Kenall's housings are aluminum, which has low resistivity and therefore an excellent shield. The housings are fabricated in-house and inspected to ensure no gaps exist that may leave the circuit board vulnerable to interference.

Finally, our robust electronic drivers are designed to withstand many small transients that exist on supply lines. These design properties ensure our products withstand pulses from 3.0T MRI units as well as emission levels in excess of 300 V/m as measured by an independent EMC test lab.

Electromagnetic Interference (EMI) Testing & Military Standard 461F

The most comprehensive, widely recognized and acknowledged domestic EMI standard is Military Standard MIL-STD-461F, a mandatory standard for military hospitals and other EMI-sensitive military facilities and a voluntary standard for public and private facilities applications. MIL STD testing measurements cover both radiated and conducted emissions, in addition to maximum allowable amounts of emitted energy based on both frequency range and field strength.

The MIL-STD-461F testing procedures and requirements appropriate to light fixtures are found under Navy and Air Force Limits for Electronic Devices, with the specific testing information for conducted emissions outlined in CE 102-1 and for radiated emissions in RE 102-4. While both are designed to emulate worst case operating conditions, both the test procedures and the standards themselves are logical and reasonable.

Kenall MedMaster fixtures have been tested and proven to be in compliance with MIL-STD-461F (Air Force/ Navy Fixed) by an independent laboratory (DLS Electronic Systems, Inc.) accredited by both NIST and the U.S. DOC. Copies of test reports are available from Kenall.

(Taken from the Kennal Catalogue: "LED Lighting for MRI Imaging Suites", http://www.kenall.com/LED-Lighting-for-MRI-Imaging-Suites.khtml?cid=518&iid=6251, downloaded 4 July 2012.)

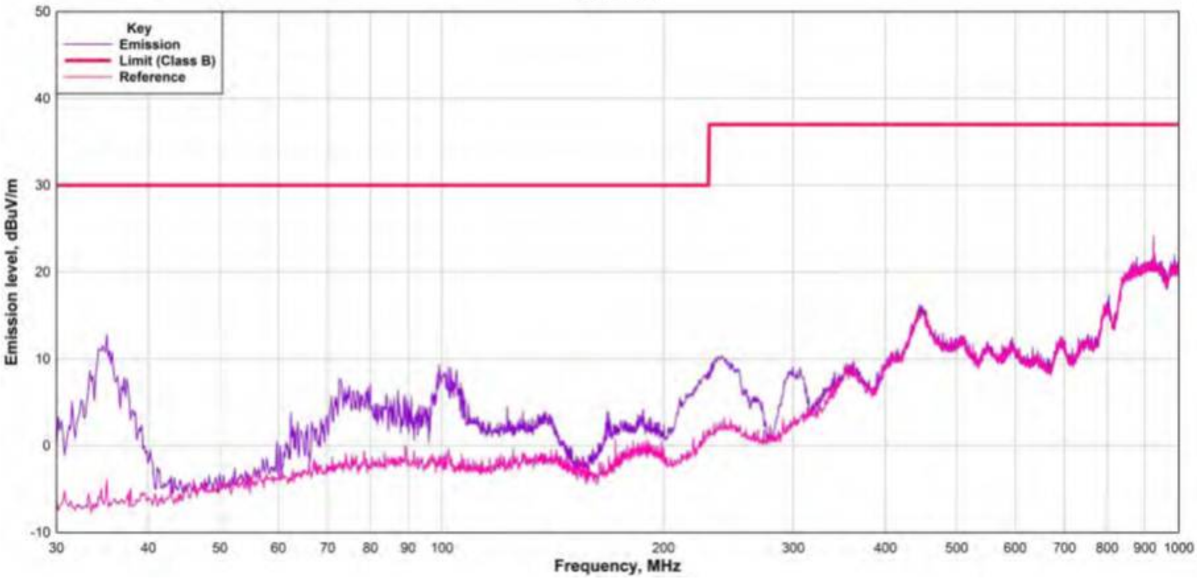
716) Controlling Marine radio EMI from LED bulbs

The Marinebeam Constant-Current chipset uses the newest wave-shaping technologies for controlling the current to the LED clusters without creating nasty Electro-Magnetic Interference (EMI).

Typical LEDs current-control methods via switch-mode converters can contribute significantly to both conducted and radiated Radio Frequency (RF) emissions, which can interfere with VHF, FM, SSB and GPS radios on board.

This EMI is typically due to manufacturer's using standard LED driver IC's which create sharp spikes in the switching frequency wave-forms, that emit RF into the air, and EMI through the wiring. This problem is compounded by poor design of the typical LED emitter boards, where the traces tend to work as mini-antenna. We address both of these important issues in our LED driver and board design.

Because our LED arrays are meant to be used on boats, where RF interference can be catastrophic, Marinebeam is using the latest technologies to reduce any RF or EMI emissions. With smartphones, airplanes and automobiles now using high-performance LEDs for illumination and backlighting, EMI issues are being addressed more responsibly by the leaders in the industry. Marinebeam is leveraging the newest wave-shaping technologies emerging in these markets to ensure we have great performing low-EMI products for our boats.



(From http://store.marinebeam.com/contolling-emi-in-led-bulbs.html, downloaded 4 July 2012)

717) Operational problems with aftermarket 2-way radios

There have been numerous incidents where poorly-shielded vehicles have developed operational issues (braking, cruise control, etc.) due to aftermarket two-way radios being installed.

(Taken from "Why are there so many standards", by Steve Hayes, Jack McFadden, Steve O'Steen, Kenneth Wyatt and David Zimmerman, in Interference Technology's on-line magazine, 11 June 2012, www.interferencetechnology.com/why-are-there=so-many=emc-standards-3.)

718) EMC problems in Formula 1 racing

"EMC has been one of the big problems with electronic systems in Formula 1,"said Lyon, who developed electronic control systems during his time with the Brawn and Renault F1 teams.

(Taken from "Driving ambitions" by Justin Cunningham and Graham Pitcher, New Electronics magazine, 24 April 2012, pages 14-17, www.newelectronics.co.uk.)

719) LightSquared denied backing by FCC

Originally, the US telecoms regulator, the Federal Communications Commission (FCC), put LightSquared on the fast track through a January 2011 decision that it hoped would rapidly create a new 4G rival for the dominant terrestrial cellular operators, Verizon and AT&T. That LightSquared's satellite-based service would bring mobile communications to rural communities also fitted well with Obama's policy of avoiding the US becoming a nation of digital haves and have-nots.

There was just one problem. The original LightSquared signal specification interfered with the Global Positioning System (GPS). Cue howls of outrage from the military, air traffic controllers and many powerful logistics players like FedEx – that latter group also containing some of Washiongton's bigger-spending lobbyists.

Falcone has long insisted that the GPS issue can be resolved before any launch, but in April, the FCC effectively removed its backing. LightSquared has been struggling ever since.

The key political issue is how the FCC could have specifically promoted LightSquared if it either did know about the GPS issue or before sufficient research had been done to uncover it. After all, GPS is by definition ubiquitous. As with Solyndra, government aggressively backed a technology that simply hadn't undergone enough due diligence.

(Taken from "Technology may prove a double-edged sword for Obama Campaign, in IET Engineering & Technology magazine, June 2012, page 15, www.EandTmagazine.com. The Editor writes: For some history on Lightsquared please look back at Banana Skin number 647, on page 15 of the July 2011 issue of the EMC Journal. Has everyone using GPS for controlling critical systems (including the entire banking system!) understood how very vulnerable it is to interference, and taken appropriate steps to manage the resulting risks effectively? The necessary information has been in the public domain and discussed in trade publications such as GPS World at least since the Volpe report (see Banana Skin numbers 223, 224, and 227 through 232 in "The First 500 Banana Skins" book at http://www.nutwooduk.co.uk/BananaSkins.aspx or purchase from www.emcacademy.org/books.asp, yet I keep meeting engineers designing major transport systems and the like who seem to think GPS is a 100% reliable service. There are many other Banana Skins that concern the unreliability of GPS (and/or Galileo, its European equivalent) due to EMI, including number 720, below.)

720) Northern Lights interfere with satellites including GPS

Oslo University scientists have developed miniature instruments that could provide useful insights into how the Northern Lights interfere with satellites.

The Northern Lights occur when electrically charged solar winds collide with plasma clouds at altitudes of 80-500km. Turbulent conditions found within plasma clouds during the Northern Lights can reflect or completely block radio signals being sent to and from satellites.

Tor André Bekking, the Oslo University research fellow who is responsible for the electronics and algorithms, said "The instrumentation uses four miniaturised cylindrical probes to measure electron density with plasma clouds."

The device – dubbed 'm-NLP' – measures electron density at a rate of 7kHz so that scientists can look more closely at what is happening in the plasma cloud.

"It is an improvement on previous instrumentation, because it gives the absolute electron density at 1m spatial resolution, compared with….the kilometre scale," said Bekking. "By having measurements of absolute electron density down to metre scale, we can, for the first time, see the smallest thinkable structures in the ionosphere, which is the height region where the Northern Lights occur.'

'The reason we want to investigate these structures is that if you have a structure that is half the size of the wavelength of the radio signal you are transmitting, you will experience backscattering and scintillation of the received signal,' said Bekking. 'For GPS this will result in reduced accuracy, and during solar storms the users can experience no GPS signal lock in high-latitude areas.'

The new device will be attached to 20 of the 50 CubeSat satellites that Bekking said are set to be launched in 2014.

(Taken from "Light touch to deal with interference", by Sam Shead, The Engineer, 28 May 2012, page 12, www.theengineer.co.uk. Also see number 653. Well-educated readers may know the Northern Lights better as the Aurora Borealis.)

721) Strongest Solar Flare of Summer Creates Strong Radio Blackout

The sun unleashed two major solar storms in a single week this month and more are expected to follow. The most recent X-class solar flare erupted toward Earth, sending a wave of charged particles that have amped up northern lights displays and caused a strong radio blackout for some high-frequency communications systems. Effects on communications were felt within minutes of the flare reaching its peak, according to the Space Weather Prediction Center.

The solar flares are erupting from Active Region 1520, an area on the sun 186,411 miles long and currently facing Earth. AR1520 also promises more storms in the near future as it is only halfway across the face of the sun so far.

(From: www.interferencetechnology.com/strongest-solar-flare-of-summer-creates-strong-radio-blackout/ 07/18/2012, learn more from "Powerful outburst on the sun sends a blast our way" by Tariq Malik, Managing editor , NBCnews.com, updated 7/12/2012 7:17:13 PM ET, www.msnbc.msn.com/id/48166317/ns/technology_and_science-space/#.UAV3t_XMRdA, follow Space.com Managing Editor Tariq Malik on Twitter@tariqjmalik. Follow Space.com on Twitter @Spacedotcom.)

722) Titanic sinking's large loss of life related to EMI

The 15th of April 2012 is the 100th anniversary of the sinking of the RMS Titanic in the North Atlantic Ocean. This article is a brief explanation of how "radio frequency interference" contributed to the totality of the disaster at sea.

The RMS Titanic had a powerful wireless telegraph on board for the convenience of passengers wanting to send messages ahead to their families. The wireless telegraphs were also used for operations of the ship.

The Titanic actually had two 1500 Watt spark-gap wireless telegraphs located in the radio room on the Bridge Deck. The Bridge Deck was the third deck from the top and the top weight-bearing deck as well as the uppermost level of the hull. One of the wireless telegraphs was used for transmitting messages and the other was used for receiving messages. The receiving unit was located in a soundproof booth so the operator could more clearly hear the incoming signals.

The signals were transmitted through two parallel wires strung between the two ship's masts about 15 meters above the funnels to avoid the corrosive smoke from the engines. The system was one of the most powerful in the world at that time and had a range of up to 1,000 miles. It was owned and operated by the Marconi Company and was intended primarily for the passengers.

The two wireless operators were supposed to operate the units on a 24-hour basis; both sending and receiving, primarily, messages for the passengers. As a side-effort, the operators also transmitted and received professional ship messages on weather reports and ice warnings.

The story has been told that many ships in the vicinity of the Titanic had turned off their wireless telegraphs because the powerful signal from the Titanic created "interference" in their wireless systems.

When the Titanic was sinking, she sent distress signals via wireless, rockets, and lamps. However, the ships that had turned their wireless systems off did not hear the distress signals. The ships that heard the wireless distress signals were too far away to help in a timely manner.

If the ships close to the Titanic had left their wireless systems "on", it is possible that many more passengers could have been saved. As it was, only 710 people survived the disaster and over 1500 people lost their lives due to the cold water and hypothermia conditions.

Most notably, the Californian was a ship that was in sight of the Titanic. The Californian had stopped for the night because of the iceberg dangers. The Californian had warned the Titanic about the ice pack but the senior wireless operator of the Titanic rebuked the Californian wireless operator. The Californian wireless operator then went to bed and slept. He was awakened at 5:30 am and asked by his captain to try and contact the Titanic. But, the Titanic had sunk at 2:20 am so no response was heard. However, he heard from other ships that the Titanic had been lost.

As a result of the disaster, the world established the International Convention for the Safety of Life at Sea (SOLAS) which included basic covenants on the number of lifeboats per ship and the training of ship's employees on the use and launching of the lifeboats.

Basic regulations were also implemented on wireless power and frequency allocation as well as stipulations that the wireless equipment was to be manned 24 hours a day.

(Taken from: "The Titanic and Radio Frequency Interference" by Dan Hoolihan, Chair of the IEEE EMC Society History Committee, in the IEEE Electromagnetic Compatibility Magazine, Volume 1, Quarter 2, 2012, page 39.)

723) RFID at 13.56MHz interferes with electronic X-Ray unit

Just FYI, I was recently on a job where a 13.56 MHz inventory control system, used in a hospital ER, was interfering with an electronic XRay unit. The source/victim distance was about 3 to 4 meters. The sensor, roughly 16X24" wirelessly communicated to the AP at the nurse station.

The RFID unit was used to track supply carts and patients who might wander off.

Since the immunity specs stop at 26MHz for this device, it would not have been tested, naturally (as there are normally no cables).

With the wide rollout of RFID systems, perhaps a look at a spot test at that common 13.56 MHz frequency may bear some consideration.

(From an email on November 19, 2011, from Mike Violette to the Jeff Silberberg, secretary of IEC TC62A MT23, responsible for the EMC standards for medical equipment and systems. Mike is with EMC Washington Laboratories & American Certification Body, mikev@wll.com,and the job he refers to is discussed more fully in "Keep Looking", In Compliance Magazine, www.incompliancemag.com/index.php?option=com_content&view=article&id=919:keep-looking&catid=60:reality-engineering&Itemid=200)

724) Products suffers two failure modes due to surges

[Manufacturer] reports two failure modes for issues with a device that communicates wirelessly with an implanted pacemaker or defibrillator and sends the data over phone lines to a secure computer account.

The device experienced electrical overstress damage from an externally sourced electrical surge within the environment, such as a power outage or lightning storm, and manufacturing quality issues.

These failures exhibit the following problems: loss of power, the power cord becomes warm or hot to touch and/or emits a burning smell (2 reports of patient getting burned), the LED on the power cord does not illuminate, power brick is deformed/melted from the heat, power brick emits a high pitched noise.

The firm reports 1,141 complaints related to electrical overstress damage and 500 complaints regarding manufacturing quality issues in the past two years.

They report this issue is being addressed by replacing power supplies with performance concerns, initiating a supplier corrective action, and by utilizing a new model of power brick supplied by [manufacturer] with a metal oxide varistor (MOV) in future [device] models. The new model of power brick is expected to improve both manufacturing quality issues and electric surge immunity. The new power brick may require a premarket submission or may be considered for a potential recall.

(From a private email on November 17, 2011, from Jeff Silberberg, secretary of IEC TC62A MT23, responsible for the EMC standards for medical equipment and systems to the Editor and the rest of MT23.)

725) Israelis might use EMP weapon against Iran

Israel could cripple Iran's power grid with electromagnetic pulses (EMPs) as part of a concerted attack to halt the Islamic Republic's military nuclear programme, it was claimed last week.

The possible use of such a weapon to send Iran "back to the Stone Age" has been raised in several quarters as a debate rages among Israel's politicians about whether a swift strike should be launched to stop Iran developing nuclear weapons.

The technology behind EMP, which is regarded as non-lethal, has been known for decades. An intense burst of gamma energy… ….with the potential to "fry" electronic devices and circuits. Although the potential of EMP was first noted as a side effect of high-altitude nuclear tests in the 1950s and 1960s, a pulse can also be produced by non-nuclear means such as a microwave generator.

Such a pulse could knock out the power grid and communications for transport, financial and emergency services.

Uzi Rubin, who helped develop Israel's anti-missile defence shield said: "The use of a nuclear device even for non-lethal use such as EMP is out of the question. There are methods to operate EMP from the ground." He said it could be used to take out Iran's radar system.

(Extracts from "Israeli gamma pulse 'could send Iran back to the Stone Age", by Uzi Mahnaimi, in "News, World" the Sunday Times, 9 September 2012, page 28, www.thesundaytimes.co,uk/news. The Editor writes – Any country with a Smart Grid or a predominance of Smart Meters would be much more vulnerable than Iran to EMP attacks, something that seems to be being overlooked in the rush towards implementing these new technologies.)

726) EMI problems with Smart Meters

One of the challenges that have already surfaced is EMI problems with solid state meters. Some utility customers in the US have experienced EMI problems with some meters. The majority of the cases reported involved high-frequency, low-power radiated emissions from the meters interfering with consumer electronic equipment. A few of the EMI cases were conducted problems.

Utilities in Germany, Italy, Sweden and The Netherlands have also experienced bi-directional EMI problems with solid-state utility revenue meters. Several problems were reported involving conducted emissions below 200 kHz from photovoltaic (PV) inverters which caused accuracy problems with the meters installed on the facilities where the PV systems were in use.

Other types of equipment (e.g., electronic lamp dimmers) besides PV inverters have also interfered with the operation of solid-state meters. Other problems involved interference to end-use equipment such as baby monitors and consumer electronic equipment.

The International Electrotechnical Commission (IEC) has already responded to documented EMI cases with solid-state meters by engaging the fast-track development of a new immunity standard to determine the immunity of meters to conducted disturbances.

This draft standard describes a test method for low-frequency (i.e., 2 kHz to 150 kHz) conducted disturbances in the differential mode. The draft standard under development, IEC 61000, Part 4-19: Testing and measurement techniques – Test for immunity to conducted, differential mode disturbances in the frequency range from 2 kHz to 150 kHz at w.c. ports to be issued in mid-2013 is a basic EMC immunity standard in the 61000 series of EMC standards promulgated by the IEC. It will likely serve as a catalyst in the near future for the development of product-specific EMC immunity standards such as one specifically for solid-state utility revenue meters.

(Taken from: "Meshing Power Quality and Electromagnetic Compatibility for Tomorrow's Smart Grid", Philip F. Keebler, Energy Utilization – Power Delivery Sector, Electric Power Research Institute (EPRI), pkeebler@epri.com, in IEEE Electromagnetic Compatibility Magazine – Volume 1 – Quarter 2, 2012, http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6244982.)

727) Increasing levels of EMI 2kHz - 9kHz on AC power distribution networks

As long as no other way is known to meet very strict compatibility requirements for permissible harmonic emission than using huge passive filter circuits (necessarily tuned to higher frequencies,(i.e. usually >1kHz), the probability increases that problems occur in the lower frequency range. This is caused by resonances with the consequence of overload and voltage stress for all electric components being used in the network itself (generators, transformers, capacitors, cables, etc.) and for all components being connected thereto.

In the past a lot of examples have shown that overload or voltage stress problems on electric components were predominantly caused by resonances or cumulating effects instead of loads issued from the normal operating conditions of electric equipment which operate correctly or from voltage distortion levels which occur under normal operating conditions of the equipment without such effects.

Conventional equipment with non-linear load characteristic draw non-linear currents from the power supply system which contain low order harmonics (usually <1.5 kHz).The probability that overload and stress problems occur increases rapidly when the non-linear current with a given frequency encounters to a resonance in the network with the same frequency.

Since decades the technicians pay attention to avoid such coincidences if imaginably possible. If filter circuits had to be installed in the past (for improving the power factor for example), it was strictly noted that the filtering procedure were started at the lowest frequency before filter circuits for higher frequencies were allowed to be switched on. The target was all the time to avoid resonances in the lower frequency range if possible. As lower the natural damping effect of the network is, as higher is the need to follow this rule.

To follow it in the range of 2 kHz to 9 kHz is very difficult and mostly impossible. The application of filter measures in a great extent is inevitable if the requirement for the compliance of a low distortion level for a specific frequency is very strict. The current praxis is therefore to install huge filter circuits with focus on a dedicated frequency in order to fulfill the requirements at the given target and to disregard undesired effects at this stage which might occur in the network later on by the mentioned coincidence with other equipment (in case of new installations or changing the network configuration for example).

(Taken from Clause A.7, "Impact of additional AIC filter measures in the range of 2 kHz to 9 kHz", in IEC/TS 62578 Ed2 Committee Draft dated 23 March 2012, published by the IEC as 77A/793/INF on 22 June 2012.)

728) Astronomers want to use the moon as an EMI shield

An astronomy team from the University of Colorado is hoping that the far side of the moon will offer their telescopes immunity from radio interference as they explore the origins of the universe.

The only way to observe these dark ages of the universe' past is to look for faint radio signals from neutral hydrogen, which filled the early universe. To do so telescopes need to receive radio waves at frequencies below 100 megahertz, and interference from radio sources on Earth such as FM radio and the planet's ionosphere can disturb these signals. Telescopes behind the moon, however, would not have to contend with Earth's ionosphere or radio chatter.

If selected as a mission by NASA, the Dark Ages Radio Explorer will orbit the moon at an altitude of 200 kilometres. It will collect neutral-hydrogen signals between 40 and 120 megahertz, which corresponds to 80 million to 420 million years after the big bang.

(Taken from www.interferencetechnology.com/astronomers-look-to-the-far-side-of-the-moon-for-rf-immunity, 07/02/2012. Learn more from "Far side of the moon offers quiet place for telescopes" by Anil Ananthaswamy, updated 15:43 03 July 2012, New Scientist Magazine issue 2871, at www.newscientist.com/article/mg21428713.300-far-side-of-the-moon-offers-quiet-place-for-telescopes.html)

729) Cellphone tower frequencies disabled after emergency communications disrupted

ATT temporarily disabled a frequency emitted by 16 towers in Oakland Calif., Tuesday, Aug. 21, after the signals interfered with emergency responder radio communications.

The towers caused radio failures in police cars and fire trucks when they were within a quarter to half mile radius, David Cruise, Oakland's public safety systems adviser, said.

FCC confirmed the interference and ATT shut down the 850MHz frequency on the towers last week – which only affected 2G customers with older phones.

The city is investigating other failures in communications involving interference.

(Taken from www.interferencetechnology.com/att-disables-tower-frequencies-after-emergency-communications-disrupted, 08/23/2012. To learn more, read "Oakland police radio culprit: cell towers", by Matthai Kuruvila, updated 10:32 a.m., Tuesday, August 21, 2012, in the San Francisco Chronicle: http://www.sfgate.com/crime/article/Oakland-police-radio-culprit-cell-towers-3802585.php or http://www.sfgate.com/crime/article/Oakland-police-radio-culprit-cell-towers-3802585.php#ixzz24SfA46bZ)

730) HDMI emissions caused by badly-made cables

Feedback from the people attending the EMC Academy training sessions at EMC-UK 2012 on the 9th and 10th of October frequently mentioned that they were having problems with the EMC of HDMI connections.

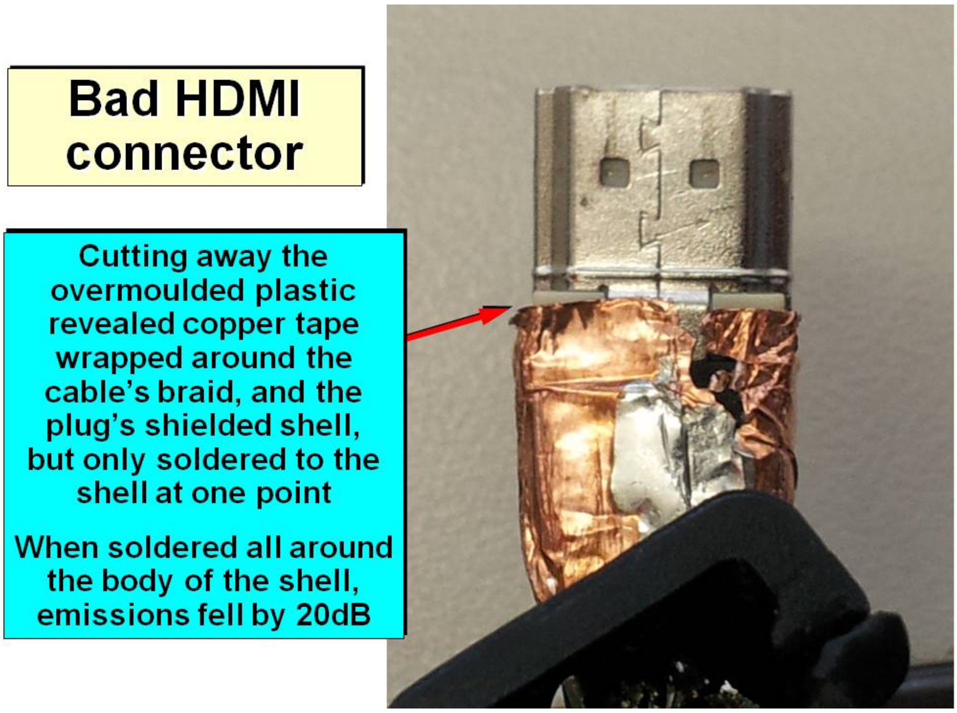
Wim Ophelders, in charge of Image Processing, Signal Integrity and EMC in the Research & Development department of Océ-Technologies B.V. in The Netherlands, has also recently been investigating the causes of excessive emissions from HDMI interconnections, and sent in the annotated photograph below on 12th November 2012.

Wim found that soldering the wrapped copper foil properly, i.e. all around the connector shells at both ends of the cable, reduced the emissions he had thought were caused by other aspects of his HDMI-connected product by so much that it now passed its EMC tests.

If this poor cable assembly is typical of purchased HDMI cables, it could well be the cause of many of the complaints about the poor EMC of this type of interconnection.

Most EMC test lab managers have long experience with poorly-constructed cables sold as “shielded” types, some of which contain shields that are not even connected to the connector shells at the ends!

A particular problem is that even if a purchased cable has good shielding performance when used with a prototype product, future batches supplied for production can suffer degraded shielding due to incorrect assembly – but of course it is impossible to tell by visual inspection because the cable-connector joints are overmoulded with opaque plastic.



Unless cables can be purchased with transparent overmoulding, the only ways to ensure that a product’s EMC performance (and legal compliance) has not been hugely compromised by the poor quality of purchased cables are:

- Assemble your own cables, don’t buy them, so that you control the quality of your EMC-critical cables yourself.
- X-ray a random sample of cables from each batch delivered, checking their internal assembly is correct before accepting them into the company stores. Although a costly solution, it may be most cost-effective because the X-ray machine can be used to check the correct assembly of any/all other components/assemblies supplied for manufacture, and also a big help in avoiding assembling with counterfeit parts.
- Using a spectrum analyser with tracking generator, two clamp-on current probes and a cable termination box fitted with two HDMI sockets, check that a random sample of cables from each batch delivered measure the same as the ‘known good’ example of the same cable that is known to help ensure that products pass their EMC tests.

731) Digital Media Players interfere with pacemaker telemetry

Background: Contemporary implantable heart rhythm devices communicate multiple complex data simultaneously using radiofrequency telemetry. Interference in communication can expose them to the risk of potential corruption, leading to adverse clinical consequences.

Methods & Results: We studied the characteristics of interference with uplink (real time intracardiac electrograms, marker channel, and stored histograms) and downlink (attempt to program a change in the lower rate limit, the pacing mode, and the ventricular lead configuration) data transmission between the wand and the pacemaker caused by digital media players (iPods—Photo and 3G) in 50 patients. We also measured and characterized worst-case magnetic field emissions (MFE) from the wand (≤0.4 μT), pacemaker (≤0.004 μT), and iPod (≤0.05 μT) during telemetry to understand the modulation techniques and safety protocols employed during data transmission.

Telemetry interference (TI) manifested as high frequency spikes (24.4%), blanking (17.7%) and interruption (22.2%), or delay (17.6%) in transmission with warning on programmer's screen. TI occurred in 25.6% of patients when the iPod was "on" and in 13% even with the iPod turned "off." There were no inaccuracies in downlinked data when the downlink communication was successful. Wanded telemetry utilizes low-frequency (30–300 kHz) radiowaves and simple digital modulation techniques at relatively slow rates for "sequential" data transmission protected by a continuous "handshake." Emissions from iPods in that range interrupt the telemetry link but are too weak to cause pacemaker malfunction through corruption of vital data.

Conclusion: Low-power MFE from iPods can produce interference with establishment and maintenance of a telemetry link and can cause TI with transmission of real time data, but because of continuous check protocols, do not corrupt the stored and vital downlink data. (PACE 2009; 1–9)

(From "Characteristics of Telemetry Interference with Pacemakers Caused by Digital Media Players" by ASHOK J. SHAH, M.D., JOSEPH D. BRUNETT, PH.D.,* JAY P. THAKER,† MEHUL B. PATEL, M.D.,* VALDIS V. LIEPA, PH.D.,* KRIT JONGNARANGSIN, M.D.,† and RANJAN K. THAKUR, M.D.‡ *Thoracic and Cardiovascular Institute, Sparrow Health System, Michigan State University, Lansing, Michigan; †Department of Electrical Engineering and Computer Science; and ‡Division of Cardiovascular Medicine, University of Michigan, Ann Arbor, Michigan, PACE 2009, Wiley Periodicals, Inc., www.ncbi.nlm.nih.gov/pubmed/20059718.)*

732) Smart grids use wireless to avoid EMI

As one of the very few smart metering providers, Kamstrup A/S (Skanderborg, Denmark) offers RF-communication in their smart metering system and has done so for more than ten years. Seen from Kamstrup's point of view, the reason why wireless systems prevail in smart grid technology is simple: RF works – a plain fact which is being corroborated by numerous, high-performing RF-based systems from all over the world.

In the past, Kamstrup offered RF and PLC solutions together, but has now terminated its PLC program as RF very soon began to show much more convincing results. The evidence is plenty. Sweden was one of the first countries to roll out smart meters nationwide, and now the Swedish case study offers experience to learn from. Many utilities who first opted for a PLC solution have afterwards switched to an RF-solution as PLC showed poor performance on meter readings, of which 60 to 90% was traceable to grid disturbances. Some have chosen to mend the problem by installing expensive filters.

Some PLC providers therefore take reservations against grid disturbances when guaranteeing 100% performance claiming disturbances to be a separate problem to be dealt with and thus pushing it back to the utility. But the fact is that cables are simply a hard environment for communication. The increased disturbance level in the grid which caused many PLC networks to fail in Sweden could for a large part be traced to the massive exchange of incandescent light-bulbs with low-energy light bulbs.

All electric devices which are connected to the grid are also potential sources of grid disturbance as they not only consume power from the grid, but also return electromagnetic disturbances. The Electromagnetic Compatibility-directive (EMC) regulates how much disturbance electric devices may cause. But even though the equipment which is now causing problems in Sweden may comply with the EMC-directive, it is still liable to influence a PLC-based meter reading system because the communication unit in the meter is affected by the total amount of disturbances generated by all installed equipment in a house. So, when substantial changes happen simultaneously – like the out-phasing of the incandescent light bulb – the meter reading system can be affected in spite of the regulatory fulfilments of the individual product.

(Taken from "Smart Grids turn to wireless systems" by Gert Skriver, in Electronic Engineering Times Europe, October 2012, page 51, www.eetimes.com/design/smart-energy-design/4398388/Smart-grids-turn-to-wireless-systems)

733) Apollo mission programme EMC problems

Forty-three years after first landing on the moon and with the recent death of Neil Armstrong I thought I would relate some anecdotes on Electromagnetic Interference associated with the successful Apollo mission program.

The Apollo 7 mission was to be a test flight with a 3 man crew and the first time the Saturn 1B rocket was used. A problem was encountered with the rendezvous radar and the telemetry systems which delayed the mission.

Filters supplied to the Kennedy Space Centre did not fix the problem. Attempts to tune the coaxial connection between the radar dish and the electronics package lessened the interference with the telemetry system, but resulted in a new interference with the abort guidance system

During the Apollo 12 and 14 missions a colour camera was introduced with less than spectacular performance. The new replacement camera to be used for the Ground Commanded Television Assembly had interference emanating from voice and telemetry subcarriers in the middle of the video bandpass.

Eventually a cancellation process was implemented that removed the offending voice and telemetry subcarriers from the lunar module downlink.

The above examples illustrate that EMC has been critical to many major endeavours. As with the space program, EMC in cutting edge projects will force engineers to push the envelope. The challenge presented by these tasks is what motivates engineers.

(Mark Mifsud, "Message from the Chairman", EMC Society of Australia Newsletter, issue 58, September 2012.)

734) Conducted Interference reduction from Compact Fluorescent Lamps

One of the most popular light sources used in houses, industries, stores, hospitals, universities, laboratories and magazines are the lamps of low pressure. One example is the Compact Fluorescent Lamp (CFL) presenting larger efficiency in terms of energy and brightness [1].

Nevertheless, the introduction of nonlinear electronic circuits in the lighting industry has also increased the electromagnetic interference (EMI) incidence. The lighting appliances, like CFL's that is broadly used, increase significantly the current and voltage harmonic levels as well as the high frequency components. It leads as consequence the interference and deterioration in equipments and circuits.

The interference from CFL's in receivers of TV VHF [5], systems with remote control [6] and relays in substations have been reported. In the last case it causes an involuntary energized relays.

[5] J. Rajamaki, "Lighting Interferences – An Ever Increasing Threat! Will the Proposed Changes in CISPR 15 Correct the Situation?" in EMC'05, 2005, p. 7-12.

[6] W.A. Anderson, E. E. Hammer and A. Serres "The Interaction of Infra-Red Controls and Electronic Compact Fluorescent Lamps" in IAS'95, p2066-2068, vol. 3.

*(Taken from "*Conducted Interference reduction from Compact Fluorescent Lamps*" by P.I.L. Ferreria, G. Fontgalland, G.F. Aragao, A.R.Z. Nascimento, R.C.S. Freire, and S.E. Barbin, 2010 Asia-Pacific International Symposium on Electromagnetic Compatibility, April 12-16, 2010, Beijing, China, ISBN: 978-1-4244-5263-9.)*

735) Electronic Damage

When a cosmic ray passes through an electronic circuit, its energy may cause a transient error to occur. This can be a problem for the electronics found in satellites, spacecraft and even aircraft. A cosmic ray may have caused the flight control system of a Quantas flight to malfunction in 2008. The aircraft plunged hundreds of metres, causing injuries to many of those on board, but was landed safely.

Software systems in aircraft have since been redesigned to average out sudden power spikes of the kind that a cosmic ray might induce. A cosmic ray is believed to have caused a malfunction two years ago aboard the Voyager 2 spacecraft, which was launched in 1977.

(Taken from "Electronic Damage", in New Scientist Issue 2885, 6 October 2012, www.newscientist.com.)

736) Cat 6 copper vs fibreoptic Ethernet in industry

Copper, now commonly installed in Cat 6 (or higher) formats, is frequently deployed in areas where there are low levels of electromagnetic interference (EMI). Local equipment rooms (LERs) containing servers, workstations and PLC interfaces, are typical applications. But when the network extends beyond these confines, such as between LERs, the distances spanned between links, the levels of EMI the cabling may be exposed to and the ground potential between facilities, where galvanic isolation may be desired, have to be considered, as they will have significant impact on the operation of a copper network.

It is at this point, says, Mr Jones, that decisions are likely to be made whether to use copper or fibre media. Fibre optics removes many of the negative aspects of copper cabling. It offers greater range than copper, it is inherently immune to EMI, it permits galvanic isolation between facilities that are at different ground potentials and it is becoming more cost competitive, given the significant rise in copper prices in recent years.

(From "Network media: economic and technical selection issues", Industrial Ethernet Book, Sept 2012, www.iebmedia.com/ethernet.php?id=8900&parentid=74&themeid=255&hft=72&showdetail=true&bb=1)

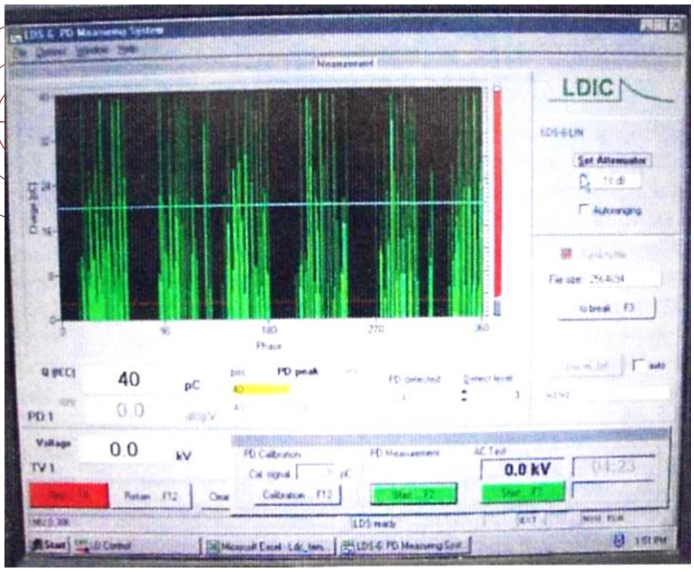
737) Noise from multiple ASDs corrupts cable test system

A popular manufacturer of electrical cables used for high-voltage overhead and underground cabling systems installed a new production line for a new type of cable. The new line utilized a variety of adjustable speed drivers (ASDs) to control the raw cable materials (two 1-horsepower ASDs), the heating and extrusion process (two 400-horsepower ASDs), and the cable take-up reel (teo 1-horsepower ASDs). The size of the line was such that the distance between the ASDs was significant. The two ASDs used to control the heating and extrusion process were closest to the large electrical subpanel that provided power to the production line. The two ASDs that controlled the unwinding of the raw materials were next, followed by the two ASDs that controlled the take-up reel. The line power for the two large ASDs (400 h.p.) was not in a conduit run, but was hung from a cable mounting system on the ceiling. Hence, these cables were long and unshielded.

Before the finished cable rolled up on the reel could be shipped to the customer, the cable underwent a partial discharge test. A partial discharge test is used to determine any leakage along the entire length of the cable. If the partial discharge test reveals a charge flow of more than 5 picocoulombs, the cable fails the test. If the test reveals a flow of less than that amount, the cable passes the test. The availability of the partial discharge test setup in the plant is a vital piece of equipment to ensure that cable reels are shipped on time.

Upon startup of this new production line, use of the partial discharge test setup revealed a problem. As shown in Figure 1, the partial discharge test system revealed a leakage much larger than five picocoulumbs. In fact, the test yielded a leakage of almost 40 picocoulombs, eight times the acceptable level. Plant engineers were concerned that the partial discharge test system was not working properly and decided that this system could not be used until someone determined the reason for the unacceptable test results.

In response to the problem, the plant staff began seeking the cause of the erroneous readings on the test monitor. Connections to the equipment were investigated. This partial discharge test system was switched with another one in the plant, and the same problem reoccurred near the new production line. The probe to the partial discharge system was also checked. Cable reels that failed the test at the problem location were taken to the other partial discharge test system and passed the test there. The manufacturer of the partial discharge system was called in, but could not determine the cause of the erroneous readings. A partial discharge test expert was also called in, and still the problem remained unsolved. After several months of investigation, the plant engineer turned to the local utility for some assistance. The local utility called upon EMC engineers to investigate the problem and to determine the cause of the problem.



Measurements were performed at the area of the line input to the ASD nearest the partial discharge test system, and a custom designed filter had to be manufactured and installed. After the EMC investigator left, the filter was installed by the electrical contractor at the step-down transformer; however, interference problems still occurred. Upon a re-examination of the filter installation, the EMC investigators quickly realised that the contractor had not followed the guidelines provided b y the team. To control the radiated and conducted emissions, the filter must be installed directly at the ASD (as close to the input terminals as possible), and the transformer must be located next to the filter to ensure proper emissions attenuation. Once corrective actions were taken, the interference was reduced and found to be at acceptable levels with all systems operating as shown in Figure 7.

Application of a 5-amp ground noise filter on the ground line of the 15-horsepower drive resulted in a reduction of noise emissions on the ground lne as shown in Figure 8. The emissions reduction, which was as much as 30dB, also reduced the background noise on the partial discharge system.

Summary

The combined radiated-conducted emissions from each of the drives in the plant affected the background noise level of the partial discharge system. The noise level was too high for the two to coexist without some mitigation measures. Even if the original installation of the 15-horsepower drive closest to the partial discharge system had contained an isolation transformer and second power line filter adjacent to the drive, the noise from the other drives would have rendered the test system non-usable. Inspection of the plant area, including the partial discharge test system, prior to the installation of the new cable manufacturing assembly line might have revealed this issue. Still, the key factor that might have helped avoid this problem would be the basic realization that partial discharge systems are indeed sensitive to emissions from devices such as drives. Shorter main conductor runs to the drives would also have helped.

The technology of the ground noise filter

The ground noise filter is a patented technology essentially comprised of a specially designed core with a few turns of solid copper wire wrapped around the core, all in parallel with a resistor. The core and turns provide an inductive impedance to the ground impedance connected to the filter. Although the filter technology is simple, it has been shown in many examples to resolve ground-related EMI problems.

(Taken from: “Case 1” in “Case Studies of EMI elimination and ground noise reduction using ground noise filters”, by Philip F Keebler and Kermit O Phipps of EPRI Electromagnetic Compatibility Laboratory, Knoxville, Tennessee, published in Interference Technology EMC Directory and Design Guide 2009, pages 102-118.)

738) Quieting down for electronic HID lighting

High-frequency electronic lamp ballast systems are being used more frequently in commercial and industrial facilities to provide a source of energy-efficient fluorescent and HID (High Intensity Discharge) lighting. Lamp and ballast manufacturers have designed many of these systems to provide high-efficiency lighting systems.

A college recently installed universal-voltage electronic HID ballasts in the gymnasium where basketball games were played. These high-efficiency electronic HID ballasts were installed to replace existing 400 watt high-pressure sodium (HPS) magnetic ballasts. After 100 percent replacement of ballasts to alleviate component-related ballast failures, the ballasts continued to fail. Following limited power quality monitoring efforts by a consulting organization, the fixture manufacturer and the ballast manufacturer suspected that there could be wiring and grounding issues within the facility. Failure of fixtures and ballasts in the gymnasium rendered the basketball court unusable if the light levels became too low. Repair of the fixtures and ballasts started to become a regular task before weekly basketball games could be played.

Our objective was to conduct a detailed on-site investigation to determine if there were wiring and grounding issues present at the college facility where these failures occurred with such frequency. We conducted a tw0-day on-site investigation of the wiring and grounding system that provides power to the lighting branch circuits used to power the ballasts.

Emissions reduction at the lighting panel

Because the level of conducted emissions was high at the ground within the panel, the investigators elected to install a 5-amp ground noise filter on the panel's main ground conductor. The installation of this filter would reduce this level of emissions and would help separate the ground of the lighting panel from the ground of the ASD panel. Figure 11 illustrates the level of conducted emissions on the ground of the lighting panel prior to the installation of the 5-amp filter (top graph) and after the installation of the filter (bottom graph). As one can see, the reduction of emissions is approximately 20 to 30 dB depending upon frequency. The installation of the filter reduced the noise emissions on the ground at the light fixtures where the electronic ballasts were used. Failures of the ballast diminished.

(Taken from: "Case 2" in "Case Studies of EMI elimination and ground noise reduction using ground noise filters", by Philip F Keebler and Kermit O Phipps of EPRI Electromagnetic Compatibility Laboratory, Knoxville, Tennessee, published in Interference Technology EMC Directory and Design Guide 2009, pages 102-118. For details of the technology of the ground noise filter, see Banana Skin number 737.)

739) External noise currents interrupt critical operations

The situation

A major building materials distribution company supplies construction projects throughout a large sector of the building industry. In fact, this entity has become the largest single source provider of environmental remediation, construction, packaging, and janitorial products in the Western United States.

The building materials company experienced serious unusual and unexplained malfunctions of end-use electrical and electronic equipment and of power distribution equipment such as circuit breakers of various sizes and their uninterruptible power supplies (UPSs). Such malfunctions had interrupted power to building loads, telecommunications, internet traffic, server operation, and the operation of the fire alarm system.

Summary

After the customer implemented the recommended changes to the wiring and ground system (including the installation of the ground noise filters), the equipment malfunctions and dropped telephone, network, and internet connections were eliminated. These filters, combined with the wiring and grounding changes, helped to isolate the customer's facility and equipment from noise from the outside electromagnetic environment.

(Taken from: "Case 3" in "Case Studies of EMI elimination and ground noise reduction using ground noise filters", by Philip F Keebler and Kermit O Phipps of EPRI Electromagnetic Compatibility Laboratory, Knoxville, Tennessee, published in Interference Technology EMC Directory and Design Guide 2009, pages 102-11. For details of the technology of the ground noise filter, see Banana Skin number 737.)

740) EM environment limitations in the safety information for a new smartphone,

Do not use your device near other electronic devices

Most electronic devices use radio frequency signals. Your device may interfere with other with other electronic devices.

Do not use your device near a pacemaker

- Avoid using your device with a 15cm range of a pacemaker, if possible, as your device can interfere with the pacemaker.
- To minimise possible interference with a pacemaker, use your device only on the side of your body that is opposite the pacemaker.

Do not use your device in a hospital or near medical equipment that can be interfered with by radio frequency

If you use medical equipment, contact the equipment manufacturer before using your device to determine whether or not the equipment will be affected by radio frequencies emitted by the device.

If you use a hearing aid, contact the manufacturer for information about radio interference

The radio frequency emitted by your device may interfere with some hearing aids. Before using your device, contact the manufacturer to determine whether or not your hearing aid will be affected by radio frequencies emitted by the device.

Turn off the device in potentially explosive environments

Turn off the device in potentially explosive environments instead of removing the battery

- Always comply with regulations, instructions and signs in potentially explosive environments
- Do not use your device at refuelling points (petrol stations), near fuels or chemicals, of in blasting areas.
- Do not store or carry flammable liquids, gases, or explosive materials in the same compartment as the device, its parts or accessories.

Turn off your device when on an aircraft

Your device may interfere with the aircraft's electronic navigation instruments.

Your device may interfere with automotive equipment

Electronic devices in your car may malfunction, due to radio interference from your device. Contact the manufacturer for more information.

Do not store your device near magnetic fields

- Your device may malfunction or the battery may discharge from exposure to magnetic fields.
- Magnetic stripe cards, including credit cards, phone cards, passbooks, and boarding passes, may be damaged by magnetic fields.
- Do not use carrying cases or accessories with magnetic closures or allow your device to come into contact with magnetic fields for extended periods of time.

(Taken from the "Safety Information" section of the User Manual of the latest model of a popular and highly-regarded smartphone, purchased in September 2012. Notice that the smartphone user is required to be knowledgeable about EM environments and potentially explosive atmospheres, and to be continually monitoring their EM environment for magnetic fields, with no maximum level specified. Also, the requirement to not use the phone "near other electronic devices" gives no guidance on what is too near. If the word "near" means the same as in the normal EMC emissions and immunity standards that are used to provide compliance with the EMC Directive, this effectively means the user instructions do not permit the smartphone to be used in any modern home, office or train.)

741) Action taken against Alternative "Energy Medicine" devices

After reports in the national media, spearheaded by the Seattle Times, about the widespread fraud and health perils inflicted on American patients by the makers of electrical devices touted as miracle cures for serious diseases such as cancer and AIDS, the Food and Drug Administration (FDA) has banned importation of the EPFX.

This desktop device is manufactured in Hungary by William Nelson, a federal fugitive who fled the country in 1996 when faced with felony fraud charges. Another electrical device under investigation is the PAP-IMI (Pap-Ion Magnetic Inductor), a 260-pound electric pulsing machine that's been linked to patient injuries and deaths. The latter is the invention of Prof. Panos Pappas, a Greek inventor and non-physician. Both these devices are based on the belief that the human body consists of energy fields and that altering those fields can improve or restore health. Apart from the obvious dangers of subjecting the ill and injured to electrical charges, physicians note the perils of delaying or rejecting medical care that might have helped.

Now the U.S. House of Representatives, Committee on Energy and Commerce's, Subcommittee on Oversight and Investigations, has instructed the FDA to provide all relevant records on these devices, their makers, and distributors. Of particular concern, is the loophole posed by the use of Institutional Review Boards (IRBs). Makers of both these devices appear to have hired private companies of medical professionals (IRBs) to evaluate their devices and to qualify them for use on patients. Examination by an IRB is not the equivalent of FDA approval, but can be used by the unscrupulous to defraud the gullible or desperate. View the entire Congressional letter online.

(Taken from: 'FDA, Congressional Sub-Committee Take Action Against Alternative "Energy Medicine" Devices', Interference Technology eNews, December 27, 2007, www.interferencetechnology.com. For more information, also see "Congress Asked to Investigate Quack Devices - Device Watch",

www.devicewatch.org/reg/inslee.pdf; http://en.wikipedia.org/wiki/List_of_topics_characterized_as_pseudoscience; http://www.camlawblog.com/promo/speaking/legal-boundaries-and-ethics-in-energy-work.)

742) Radio Mast EMI Case Headed to Court

A farmer in Purnim, a township in Victoria, Australia, is on his way to the Supreme Court in his battle against broadcasting company Ace Radio over the location of transmission masts. Independent testing carried out by EMC Technologies showed electromagnetic interference was occurring in the house, and the farmer claims the radio towers are interfering with his telephone, fax, computer and radio and affecting his animals.

PURNIM farmer John Howard is on his way to the Supreme Court in his battle against Ace Radio and Moyne Shire Council over the location of radio masts. Mr Howard, who lost a Victorian Civil Administrative Tribunal (VCAT) appeal on the matter, has been granted leave to appeal to the Supreme Court of Victoria. Two Ace Radio transmission masts on a property opposite Mr Howard's house on Blighs Road were built 126 metres and 58 metres closer to his house than the original planning permit specified. The towers are also 11 metres taller than the original specification and have 15 guy wires instead of eight. Permission to vary the position was given verbally by a Moyne Shire officer. Ace Radio, which owns Coast FM and 882 3YB, and Moyne Shire Council are named as respondents in the case, due to be heard in May. Mr Howard has a document from the Minister for Planning Justin Madden that says: "Changes to a planning permit can not be verbally approved under Victorian planning legislation. "The permit was retrospectively amended on June 16 this year, after the towers had been built, following a review by VCAT.

Mr Howard said the towers were causing interference with his telephone, fax, computer and radio as well as affecting his animals.

The revised siting of the masts put them closer to power lines that connect to Mr Howard's house, which he believed to be a factor in the interference. Independent testing commissioned by Ace Radio and carried out by EMC Technologies, showed electromagnetic interference was occurring in the house.

Mr Howard said his bore pump had blown up twice and an electric fence had been damaged during thunderstorms since the installation of the masts. The report by EMC Technologies said the ground current associated with lightning strikes could affect equipment connected to the mains. Mr Howard wants the towers moved to their originally planned positions or his house and sheds relocated. Moyne Shire has estimated the cost of moving the buildings at $880,000.Mr Howard said the battle had already cost $500,000."I stand to lose the farm over this," Mr Howard said. "I have done nothing wrong and I'm determined to see that the council is held responsible for the action of its officer who gave verbal consent when he had no right to do so." Moyne Shire chief executive Brett Stonestreet declined to comment.

(Taken from Interference Technology magazine's on-line newsletter, http://72.29.76.194/~interfer/radio-mast-emi-case-headed-to-court/, 12/16/09 03:37 PM, and from the original article from The Standard newspaper: "Supreme Court Date Set", by Steve Hynes, Nov. 25, 2009, 10:33 a.m. http://www.standard.net.au/story/740348/supreme-court-date-set/.)

743) Interference Stymies Radio Test

The BBC has released a report on its year-long test of digital medium wave (DMW) radio (or digital radio mondiale (DRM) radio) that is reported to offer a more robust signal that carries for greater distances than analog radio broadcasting.

The trial was held in southwest England using the frequency of BBC Radio Devon and was codenamed project Mayflower.

Volunteer listeners reported favorably on the quality of daytime broadcasts, but attempts at broadcasting after sunset were another story.

Nighttime changes in the atmosphere allow for distant off-shore signals to interfere with DRM, which in turn ceases to decode the signal causing an interruption in reception.

BBC spokesman said that the problem would require re-planning the transmission network and/or the building of new transmitters.

Industry analysts have concluded that the switchover from analog radio broadcasts is still some time away. The entire 11- page report on Project Mayflower has been posted online: http://downloads.bbc.co.uk/devon/pdfs/project-mayflower-summary-report.pdf.

From the official report:

Given the additional interference to medium-wave services from distant interferers which is apparent at night-time, the night-time coverage was always expected to be smaller than the daytime coverage. Indeed, the DRM coverage at night is larger than the equivalent ‘clean’ AM coverage at night.

It is important to note that the frequency we were using for DRM at Plymouth is particularly susceptible to interference from distant transmissions, although it is not atypical of the situation that occurs on many AM frequencies assigned to BBC Local and network radio in the UK. In some areas, the frequency allocated may be very much clearer of interference and so the difference between daytime and night-time reception will be less marked: it is possible that the frequency allocated to BBC Radio Scotland (810 kHz) is one such example.

However, a difference between the daytime and night-time coverage of the transmission will always present a problem, even if the night-time coverage is greater than the claimed AM coverage at the moment. This is for three principal reasons.

First, the enormous area which appears to be served by DRM during the day means that the contrast between the night-time and daytime coverage is even greater and potentially affects even more people. Medium-wave transmitters are typically planned on the edges of cities, so that the main centre of population is comfortably within the night-time coverage area of the AM. However, if DRM is capable of serving a wide-area then it stands to reason that neighbouring centres of population – previously outside both daytime and night-time coverage – will now be daytime only.

Second, whilst the night-time coverage of DRM is greater than the equivalent ‘clean’ AM coverage, it is apparent that the technical limit of AM coverage is not the same as the limit at which listeners will stop listening to it. Thus, listeners will tolerate much more cross-talk from interfering sources than is catered for in international planning standards, even more so if it is content that they especially wish to hear.

Similarly, listeners will listen to field-strengths well below the international limits even if the result is audio which is covered in static and noise. For this reason, the area in which listeners expect to be able to receive AM at night is almost the same as the area in which they can receive it during the day; and is very much bigger than the technical limit of AM coverage.

Third, the failure mode of DRM is – as with all digital systems – dramatic. The transition from working perfectly to not working at all is fairly sudden, even considering that DRM is designed to provide a measure of graceful degradation for longer than some other digital systems. Thus, listeners who previously received a degraded, interfered-with AM service at night now received nothing. At other times, given the dramatic fluctuation in interfering signal strength, listeners found the radio services dropping out – or burbling, or becoming ‘metallic’ in sound – and taking some while to restore, despite any actions they took.

(Taken from” Interference Stymies Radio Test” in Interference Technology Magazines on-line newsletter: http://72.29.76.194/~interfer/interference-stymies-radio-test/, 05/27/09 04:36 PM, and from http://downloads.bbc.co.uk/devon/pdfs/project-mayflower-summary-report.pdf.)

744) James C Klouda, RFI expert

Jim, it will be recalled, recognized at a very early stage the need for testing electronics and receivers for radio frequency interference.

Interestingly, his first real world application of his EMC background was at the start of his EMC career in the early 1950's. He had just graduated from the Illinois Institute of Technology and took a job at Chicago Aerial Survey in Chicago. There was interference to a new aerial camera aboard a US Air Force bomber. The camera caused interference to the bomber's autopilot programming.

Jim was called and after review of the situation had shielding installed by the manufacturer's camera. This solved the problem and there were no further EMC issues with the autopilot system. From that point on he became the RFI expert.

(Taken from "Completed Careers", by Don Hierman, Associate Editor, IEEE Electromagnetic compatibility magazine, Volume 1, Quarter 3, 2012, page 58, http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=06347052.)

745) Beer Blacks Out TV

In a reprint of a United Press International Dispatch (dated May 31, 1962), it was stated: "Rochdale, England – Television sets in the neighborhood of the Dog and Partridge pub are back to normal now that they discovered that the trouble was caused by beer.

Engineers found interference was caused every time the barkeeper drew a beer from one of the pub's seven spigots, so they 'neutralized' the spigot."

(Taken from "50-25-10 Years Ago: A Review of EMC Society Newsletters, by Dan Hoolihan, Associate Editor, IEEE Electromagnetic compatibility magazine, Volume 1, Quarter 3, 2012, page 22, http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=06347047.)

746) Oops, that was a 1,550 Amp Lightning test, not 150 Amp!

Pat André of André Consulting, Inc. shared a story that reminds us that it is good practice to ask more questions, even if the answers seem obvious, to get the needed solution. As usual, the story is told from Mr. André's perspective.

"While consulting for a client, I was approached by a different company who was performing lightning testing at the same laboratory as my client's. This company was having a great deal of difficulty passing a lightning test. When I saw the unit and the test they were trying to pass, my first question was, "Can you shield these cables?" I was told no.

The unit was small, and although the test levels were not very high, the size of the transient suppression required to pass this test would not have fit inside the box. So we tried several other filtering techniques, with very little success. Therefore, in desperation, I questioned the client more about the shielding issue, with the thought of approaching their customer and requesting if we could shield the signal cables in question.

They told me it was not the customer who said they could not shield the cables, but another consultant - who was worried about "ground loops" (What?). Once I was clear on this, we went to their engineering laboratory, grabbed some overbraid, and shielded the signal lines, assuring both ends of the shield were well bonded to the connectors.

Back at the testing laboratory, the test engineer and the head engineer from my client's company were both weary after many failures. So, starting at a low level, 100 amperes injected current, they slowly worked their way up to the test limit of 150 amperes.

After passing at 140 amperes, the test engineer said, "Okay, are you ready for 150 amperes, the full test level?" We all assured him that we were ready. When the test engineer initiated the test, we immediately heard a large BANG! We watched in stunned disbelief as sparks flew and smoke escaped from each connector.

My client looked like he was ready to change careers, hanging his head in defeat. At that point, the test engineer turned to me and apologetically said, "Oops. That was 1,550 amperes."

Now that I knew the reason for the sparks and smoke, I turned to the customer engineer and said, "Wait, this may be okay. Check the unit. Is it still working?" After a moment, he said, "Yep. It's working fine!"

I told the customer engineer that I could get off his payroll at that point, since his unit appeared to pass at 10 times the test level. But, he would have none of that. He told me that I was to sit there and watch the rest of the four hours of testing. The rest of the morning was quiet, and I almost felt guilty for invoicing them for that time. Almost. I was just glad I pursued the shielding question."

(Taken from "Chapter Chatter" by Todd Robinson, Associate Editor, IEEE Electromagnetic compatibility magazine, Volume 1, Quarter 3, 2012, page 8, http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=06347045.)

747) Nikon D800 Wireless Memory Card Issues Caused By RF Interference

Eye-Fi, the manufacturer of SD memory cards and SDHC cards with Wi-Fi, has released a solution to an issue that prevented their cards from working with the Nikon D800 and D800E.

In early October, Eye-Fi confirmed a compatibility issue that impacted the use of Direct Mode in the Nikon D800. Though the two products were marketed as compatible, consumers were "unable to use Eye-Fi's Direct Mode, and in some cases unable to use any of the card's Wi-Fi capabilities as all."

According to an Eye-Fi representative, the company determined the issue was caused by interference emanating from the unique USB 3 connector inside the camera. The update provided by Eye-Fi changes the card's broadcast channel to prevent further interference issues.

"By default, Direct Mode broadcasts on channel six. In the D800, due to noise that's coming from the USB 3 interface, we needed to broadcast on channel 11," Ziv Gillat, Eye-Fi co-founder, said.

More details from Imaging Resource:

Makers of the Eye-Fi wireless memory cards this week released a fix to an issue that kept their cards from working fully with the Nikon D800 and D800E. The problem, according to an Eye-Fi representative, is caused by noise coming from inside the camera, specifically from the D800's unique new USB 3 connector. Posted on Monday, the update works around the issue by changing the card's broadcast channel.

Eye-Fi's Direct Mode allows a direct connection to devices that can't create a Wi-Fi hotspot.

Early last month, reports surfaced of an issue with Eye-Fi's WiFi-connected SD cards, when used in the full-frame Nikon D800 and D800E digital SLRs. Although the two products were said by their makers to be compatible, users found themselves unable to use Eye-Fi's Direct Mode, and in some cases to use any of the card's Wi-Fi capabilities at all. Now, Eye-Fi has issued a fix, and a statement from Eye-Fi co-founder Ziv Gillat published by The Phoblographer suggests that radio frequency interference from the D800 body is to blame.

"By default," said Gillat, "Direct Mode broadcasts on channel six. In the D800, due to noise that's coming from the USB 3 interface, we needed to broadcast on channel 11."

Nikon's D800 is the first DSLR with USB 3.0 connectivity, but Eye-Fi has discovered that it can interfere with the default channel used by its Wi-Fi connected flash cards.

Nikon's D800 is the first DSLR with USB 3.0 connectivity, but Eye-Fi has discovered that it can interfere with the default channel used by its Wi-Fi connected flash cards.

Although the problem prevented use of Direct Mode with the D800 and D800E bodies, there was no risk of data loss; images were still written to the flash card, even if they could not be transmitted wirelessly.

Some users have reported more general problems with Wi-Fi beyond the Direct Mode, though, and Eye-Fi's fix doesn't specifically address this. (Nor could problems in other modes be addressed by firmware, if the problem is indeed caused by RF interference on specific channels, as the channel is set by the access point, not the client.) Of course, if you are having problems beyond Direct Mode and have access to the router, it would seem logical that configuring it to use channel 11 -- if too many adjacent networks aren't already using that channel -- would be likely to help the situation.

More details on the firmware update can be found on the Eye-Fi website.

(Taken from www.interferencetechnology.com/nikon-d800-wireless-memory-card-issues-caused-by-rf-interference/, 12/19/2012, and also from Imaging Resource: "D800 compatibility problems caused by RF interference, says Eye-Fi", by Mike Tomkins, posted Wednesday, November 21, 2012 at 7:31 PM EST www.imaging-resource.com/news/2012/11/21/d800-compatibility-problems-caused-by-rf-interference-says-eye-fi. Also of interest is the Nikon Rumors site: http://nikonrumors.com/2012/11/20/eye-fi-cards-now-compatible-with-the-nikon-d800-camera.aspx/.)

748) "Survival of the Fittest" – EMC in Electric Power Substations

When a short circuit occurs in a transmission substation (usual definition – voltages above 100,000 volts), the resulting fault current is spectacular. In some substations, it may be as high as 80,000 amperes.

Let's assume the fault was caused by the flashover of a porcelain insulator supporting a section of the high voltage power line a few towers away from the substation, due to a buildup of sea salt. The protective relays monitoring this transmission line detect this abnormally high current, and close their "trip" contacts – which then cause both the high voltage circuit breakers connected to this transmission line to open – and thus "clear the fault".

But while the fault exists, this high current is flowing from the tower to ground, then through the earth back to the substation. And since there is a finite (non-zero) resistance to "true earth ground", this causes the entire substation ground matt voltage to rise. However, this is a 60 Hertz voltage, and adequate insulation - in control circuits and electromechanical protective relays - for this well recognized "ground potential rise" has been defined for years in protective relay standards (e.g. ANSI C37.90).

It is the time to "clear" (interrupt) high fault currents - and particularly three phase faults - that determine how long a given electric utility (or an interconnection of several utilities) can remain stable after the fault has cleared.

In the late 1950s, high voltage circuit breakers began being manufactured with a guaranteed fault clearing time of two cycles (at 60 Hz) or less - and at a modest premium over three cycle breakers. This was a substantial improvement, and many were installed. But due to the inertia of its moving parts, there are finite limits to the operating speed of electro-mechanical protective relays. So with the invention of the transistor, there was an immediate interest in utilizing these "static" (no moving parts) components in new designs of transmission line protective relays, as they held the promise of saving another full cycle (16.67 milliseconds) off the overall operating time of the relay/circuit breaker combination.

Beginning in the late 1950s, General Electric and Westinghouse designed and built "static terminals" whose designs were thoroughly tested on model power system simulators. These simulators were vital "proof testing" tools to examine all varieties of single phase, double phase, line-ground, line-line, and three phase faults at various distances on two and three terminal lines. They did operate much faster, and were beginning to be widely deployed. Then the transistor components in these "static terminals" began to fail – and with no apparent connection to any high current (short circuit) event at or near the substation. What a mystery!

Even more troubling was the fact that the failures were occurring on static terminals in relay control houses, often many feet/meters from the high voltage bus work. The failures were in the transistors connected to the VT, CT, and DC control conductors in the control house.

Slowly energizing or de-energizing just one of the capacitance elements (e.g. capacitor banks, coupling capacitor voltage devices, circuit breaker bushing capacitance) as shown in Figure 1 can create the oscillatory Surge Withstand Capability (SWC) transient. Because of the slow moving switch, the result is a sequence of flash-overs (energizing) followed by decaying oscillations to zero, then repeated until the switch is fully closed or open.

The rise time was in the micro-second range to a peak of several kV, the oscillations in the 1 Megahertz range decaying to 50% in a few cycles, with repeats at many times per second. This transient now is a part of IEEE standard C37.90.1 as the "oscillatory SWC test". From its beginning in 1974, the required peak voltage for this transient test has been 2.5 kV at all locations (indoor and outdoor).The comparable IEC standard (IEC 60255-28) requires this level for outdoor installations, but only 50% of that for indoor installations.

In the mid 1970s, at Philadelphia Electric's Eddystone Generating Station, a control technician was beginning the task of tuning the excitation system of one of the 380,000 kW supercritical steam turbine-generators. He was bent over the excitation system's control panel, and his 5 watt "walkie-talkie" transceiver was clipped to the belt at the center of his back. When he pressed the "Push to Talk" button on his microphone, his back (and the radio's antenna) was much less than 1 metric meter from a static transformer differential relay for the unit's step-up transformer. The relay had been designed to meet the then current RF immunity level in IEEE Std C37.90.2 (10 volts/meter).

That standard also included, in boldtype, a "Caution" statement alerting users to maintain a separation distance of at least one (metric) meter between a transceiver's antenna and any sensitive equipment. However, with less than half that separation distance, the RF field strength at the relay was much higher than 10 V/m. The relay incorrectly operated, and the turbine-generator tripped off line. The next revision of IEEE standard C37.90.2-1995 raised the required immunity level to 35 V/m – which is the RF field strength from a 5 watt transmitter's antenna at a distance of 50 centimeters (~ 6 inches) where it remains today.

In spite of repeated attempts by electric utility engineers who are members of their county's IEC TC 95 delegation, the immunity level specified in IEC standard 60255-26 "for measuring relays and relay systems" remains at 10 V/m.

In the late 1970's, a vacuum tube based automatic synchronizing relay failed catastrophically. More specifically, a transient of unknown origin had caused a hole to be burned through the glass envelope of a vacuum tube in its operating circuitry.

The failed relay was mounted on the control panel for a barge mounted peaking gas turbine-generator at the Consolidated Edison's Gowanus Generating Station. There was no voltage on the barge higher than 15 kV, and even so, the relay design had been tested and met the oscillatory SWC test (now in IEEE Std C37.90.1). William E. Kotheimer was able to replicate the failure; he burned a similar hole in the vacuum tube's glass envelope. But this time, with an even better storage oscilloscope, he was able to capture the source of the transient. It was the seemingly innocuous DC auxiliary relay on the same panel - a GE HFA six pole hinged armature auxiliary relay designed for use in interlocking circuits. There was no operating speed requirement as the most important design criterion was low battery drain. In some applications, the relay might remain energized for weeks or months. The manufacturer's catalog listed the 125 V coil as 2000 ohms (thus a low battery drain of 62.5 milliamps).The catalog included no information as to the coil's inductance. After all, it was just a simple auxiliary relay.

The transients were generated when a slowly opening external contact attempted to interrupt that 60+ milliamp current through the HFA relay's 25 henry operating coil. As the external contact energizing the relay slowly opens, the stored inductive energy in its 25 H operating coil raises the voltage across the contact until it arcs over and the DC current resumes. This scenario keeps repeating until the external contact has opened far enough so that the arcing stops. But now, the stored energy in that relay coil is released to charge the stray capacitance of the relay panel wiring connected to the positive terminal of the HFA coil.

Now the rise time was much faster (5 nanoseconds vs. 75 ns) to a peak of 4 kV (vs. 2.5 kV), and lasted longer (1 minute for each polarity versus 2 seconds). Even more troublesome was that some of the Zener diodes that had been used in relays as mini-transient suppressors of the oscillatory SWC test did not conduct fast enough to dissipate the energy in the fast transient voltage wave form, and partially punctured. This created a high resistance leakage path, and successive fast transients created more paths until the Zener failed thermally from excessive heat from the leakage current. This failure mode was difficult to diagnose, as the thermal failures occurred hours or days after the last fast transient.

The fast transient oscillatory SWC test was added to IEEE standard C37.90.1 in 1989. This 4 kV test voltage is required whether the installation is indoor or outdoor. Note IEC 602555-26 reduces the test level 50% for indoor installations.

(Taken from: '"Survival of the Fittest" – EMC in Electric Power Substations' by John T. Tengdin, P.E., OPUS Consulting Group, j.t.tengdin@ieee.org, Co-Chair, IEEE Power and Energy Society (PES) Working Group C2 (Substations), published in the IEEE Electromagnetic Compatibility Magazine – Volume 1 – Quarter 2, http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6244983.)

749) Pocket Wi-Fi hotspots paralyse Chinese metro lines

Shenzhen Metro is blaming customer Wi-Fi for disruptions to its service. The subway system for the city of Shenzhen in Guangdong province, China, depends on the unlicensed 2.4GHz band to link up its signalling systems.

Following network failures in October, and a trial blocking of 3G signals earlier this month, the Shenzhen tube operating company wrote to China's regulator asking for permission to block the signal. Caijing magazine [1] reports that permission has now been refused, leaving Metro bosses at a loss on how to resolve the issue - which has seen two lines of the network repeatedly shut down and threatens other systems around China.

Customer Mi-Fi devices create Wi-Fi hotspots that are backhauled over China Mobile's 3G network, and they're very popular, particularly in Shenzhen - which, the South China Morning Post tells us, accounts for 80 per cent of sales [2]. That's the legit kit, which only nudges the 100mW legal cap, but engineers trying to keep the network running reckon black-market devices are kicking out three times that amount. They add that once eight of either kind come into range then the Metro's signalling system stops.

2.4GHz is reserved, globally, for unlicensed ISM (Industrial, Scientific and Medical) use, largely because it was considered worthless as it gets absorbed by water and because the band is rife with interference from microwave ovens. However, radio is a lot cleverer these days, and Wi-Fi is squeezing every cent out of the spectrum while Bluetooth dances around it, and numerous door locks, remote controls and other consumer devices fill any gaps which remain.

Originally it was the unlicensed nature of the band which made it so popular, but these days it is also the low cost of the kit. International standardisation means a Wi-Fi router, Bluetooth headset, or just a radio chip, can be sold anywhere - providing massive economies of scale.

There's also the freedom from regulatory process. Set up a link at 5.8GHz and (in the UK) you'll have to fill in forms and register each transmitter, but do the same thing at 2.4GHz and there's zero paperwork, making deployment quicker and cheaper.

The combination of these things drove Shenzhen Metro to connect up its signalling system at 2.4GHz, only to discover that it is now polluted with customer connections.

And Shenzhen is far from alone in its plight, as the same band is used by metro systems all over China, which will similarly fail once Mi-Fi devices become popular.

Blocking the 3G signal shuts down the devices, but it's hardly a sensible solution as it aggravates commuters. However, shifting to a licensed band will be expensive - both in terms of the equipment it will require and the frequencies in which it can operate.

Links: http://english.caijing.com.cn/2012-11-20/112296950.html; www.scmp.com/news/china/article/1084297/shenzhen-metro-shuts-3g-service-day-after-trains-inexplicably-stop

(Taken from "Pocket Wi-Fi hotspots paralyse Chinese metro lines. Using free band to run trains oddly didn't turn out well" By Bill Ray in The Register, http://www.theregister.co.uk/2012/11/21/wi_fi_knockout/?goback=%2Egde_3828357_member_188377735, also at: www.theregister.co.uk/2012/11/21/wi_fi_knockout/, and very kindly sent in by both Les McCormack and Chris Zombolas. Another link is: http://tinyurl.com/bwag996.)

750) High Power Microwave Missile Disables Computer Systems in Boeing Test

Aerospace company Boeing has successfully completed initial testing on a non-explosive missile that emits high powered microwaves to disable computer and electrical systems. The Counter-Electronics High-Power Advanced Missile Project (CHAMP) was tested at the Utah Test and Training Range by members of Boeing Phantom Works, the U.S. Air Force Research Laboratory and Raytheon Ktech.

In the initial test, CHAMP was fired at a two story building built on the test range and emitted a burst of high power microwaves that knocked out rows of personal computers and electrical systems inside the building. The television cameras set up to record the test were also disabled. CHAMP hit a total of seven targets with high power microwaves over a one-hour time period.

According to Keith Coleman, CHAMP program manager for Boeing Phantom Works, the successful completion of testing "marks a new era in modern-day warfare" where the technology may be used to disable the enemy's electronic and data systems before any troops or aircraft arrive. Boeing hopes that the project will change modern warfare by defeating electronic targets with little or no collateral damage.

(Taken from www.interferencetechnology.com/high-power-microwave-missile-disables-computer-systems-in-boeing-test/, 10/23/2012, for more info, visit: www.boeing.com/Features/2012/10/bds_champ_10_22_12.html)

751) Nine people killed in train collision, $12m damage, due to spurious (parasitic) oscillation

Abstract: On Monday, June 22, 2009, about 4:58 p.m., eastern daylight time, inbound Washington Metropolitan Area Transit Authority Metrorail train 112 struck the rear of stopped inbound Metrorail train 214. The accident occurred on aboveground track on the Metrorail Red Line near the Fort Totten station in Washington, D.C. The lead car of train 112 struck the rear car of train 214, causing the rear car of train 214 to telescope into the lead car of train 112, resulting in a loss of occupant survival space in the lead car of about 63 feet (about 84 percent of its total length). Nine people aboard train 112, including the train operator, were killed. Emergency response agencies reported transporting 52 people to local hospitals. Damage to train equipment was estimated to be $12 million.

Investigation Synopsis: The National Transportation Safety Board's investigation found that the Metrorail automatic train control system stopped detecting the presence of train 214 (the struck train), which caused train 214 to stop and also allowed speed commands to be transmitted to train 112 (the striking train) until the collision. This loss of detection occurred because parasitic oscillation in the General Railway Signal Company (GRS)/Alstom Signaling Inc. (Alstom) track circuit modules was creating a spurious signal that mimicked a valid track circuit signal, thus causing the track circuit to fail to detect the presence of train 214. The investigation found that the track circuit modules did not function safely as part of a fail-safe train control system because GRS/Alstom did not provide a maintenance plan that would detect anomalies in the track circuit signal, such as parasitic oscillation, over the modules' service life and prevent these anomalies from being interpreted as valid track circuit signals.

The investigation examined two near-collisions in 2005 near the Rosslyn Metrorail station that were the result of a loss of train detection. The track circuit in that case failed to detect the presence of stopped trains between the Foggy Bottom and Rosslyn stations. Tests on the circuit modules from the Rosslyn event conducted in 2009 as part of the Fort Totten investigation showed that the Rosslyn modules exhibited parasitic oscillation, and archived data showed that the Rosslyn track circuit had experienced this problem from as far back as 1988 (the earliest time from which data were available). In response to the Rosslyn event, WMATA developed, and issued technical bulletins requiring the use of an enhanced circuit verification test procedure. However, none of the WMATA technicians interviewed as part of this investigation was familiar with the enhanced procedure.

(Taken from: "Collision of Two Washington Metropolitan Area Transit Authority Metrorail Trains Near Fort Totten Station, Washington, D.C., June 22, 2009", Railroad Accident Report NTSB/RAR-10/02, National Transportation Safety Board, Washington, DC,. 2010, www.ntsb.gov/doclib/reports/2010/RAR1002.pdf.)

752) The costs of poor power quality, a CIGRE/CIRED report

Many professionals, including industry regulators, consultants, system and installation designers, maintenance managers, production managers, and financial managers, are concerned about the impact of the costs of poor power quality on businesses and how these costs can be managed.

Techniques for avoiding or reducing the impact of power quality issues are well known and the cost of their deployment relatively easily determined. However, assessing the potential cost impact of power quality (PQ) issues is difficult because, for example, the incidence of problems, the response of equipment, and the effect on process continuity are statistical in nature and are difficult to quantify. Although there have been numerous case studies, there has been, so far, no consensus on how the calculation or assessment of these costs should be approached.

This report provides a methodology for examining the economic framework for PQ. It will enable all interested parties to establish costs and benefits of PQ improvement and mitigation measures in a consistent and open manner.

Studies in the USA

In year 1993, Clemmensen [46] provided the first-ever PQ cost estimate for U.S. manufacturing sector. The estimate derived that annual spending on industrial equipment due to PQ problems could sum up to $26 billion dollars for the U.S. manufacturing sector. It was estimated that for every manufacturing sales dollar, 1.5 to 3 U.S. cents (i.e., 1.5% - 3%) are spent to mitigate PQ problems.

A few years later in 1998, Swaminathan and Sen [46], in a Sandia National Laboratory report, estimated that U.S. annual power interruption cost reaches $150 billion. This estimate was based on a 1992 Duke Power outage cost survey in the U.S. that manipulated industrial electricity sales as the basis for the estimate.

Later in year 2001, EPRI's Consortium for Electric Infrastructure to Support a Digital Society (CIEDS) [47] produced a report based on a Primen survey in the United States. The report identified three sectors of the U.S. economy that are particularly sensitive to power disturbances:

- The Digital Economy (DE): telecommunications, data storage and retrieval services, biotechnology, electronics manufacturing, and the financial industry.
- Continuous Process Manufacturing (CPM): paper, chemicals, petroleum, rubber and plastic, stone, clay and glass, and primary metals.
- Fabrication and Essential Services (F&ES): all other manufacturing industries, plus utilities and transportation facilities.

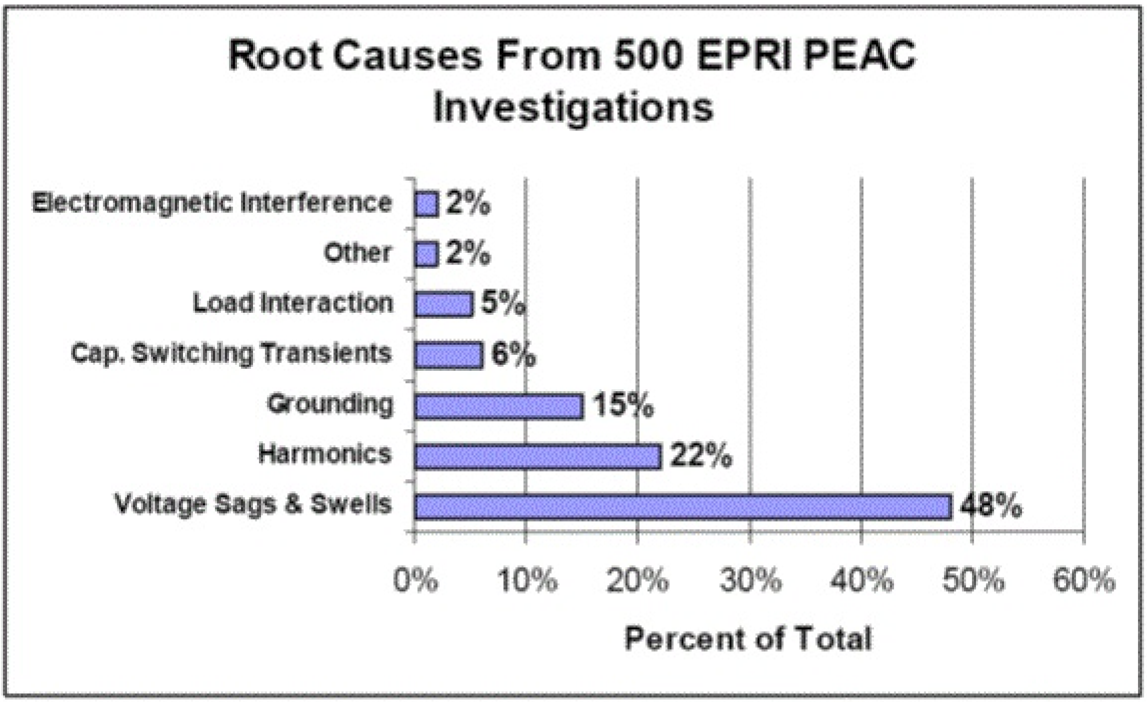


Figure 5.1 Breakdown of the power quality phenomena found in more than 500 EPRI investigations

These three sectors collectively lose $45.7 billion a year due to outages and another $6.7 billion a year due to other PQ phenomena. It is estimated that the U.S. economy losses between $104 billion to $164 billion due to outages and another $15 billion to $24 billion due to PQ phenomena.

(Some extracts from the Introduction to "Economic Framework For Power Quality", CIGRE/CIRED Joint Working Group, C4.107, June 2011, ISBN: 978- 2- 85873- 157-2, available from http://www.scribd.com/doc/71715649/467-Economic-Framework-for-Power-Quality. Also see "THE ECONOMICS OF POWER QUALITY – A SYSTEMATIC FRAMEWORK FOR THE ASSESSMENT", by José Luis Gutiérrez Iglesias, The Members of JWG C4.1071, and Alex McEachern, C I R E D 19th International Conference on Electricity Distribution Vienna, 21-24 May 2007, Paper 910, http://www.cired.be/CIRED07/pdfs/CIRED2007_0910_paper.pdf)

753) Earth's magnetic field reversal possible – knocking out satellites

Could we be witnessing the start of a reversal of Earth's geomagnetic field? That's the tentative suggestion from computer models created by Peter Olson and Renaud Deguen of John Hopkins University in Baltimore, Maryland (Nature Geoscience, DOI: 10.1038/ngeo1506). A reversal could expose us to solar winds capable of knocking out power grids.

(Taken from "Magnetic reversal?" in the "60 Seconds" column of New Scientist, 7 July 2012, page 7, www.newscientist.com. The geological record shows that the earth's magnetic field has reversed many times in the past, so it is expected to reverse again in the future. When it changes, it seems to change quite quickly, with a period of low or zero field inbetween. Many satellites would also be exposed to increased radiation, shortening their operational lives, in such a situation - Editor.)

754) Only 17.3% of LED lighting products sold in the EU complied with EMC Directive in 2011

Eighteen national market surveillance authorities (MSAs) involved in EMC ADCO participated in the campaign which was conducted between the 1st of January and the 30th of June 2011.

A hundred and sixty-eight (168) products were obtained and evaluated. Ninety one (91) LED lighting equipment products were of Chinese origin, whereas the origin of sixty-five (65) products could not be determined.

Technical compliance with harmonised standards

The notion of "compliance" is to be understood as compliance with an applicable harmonised standard.

The results of the technical compliance with the applicable harmonised standards showed large differences:

- Rather low compliance with the emissions limits: 61.5% of the tested, one hundred and sixty-six (166) products were found to be compliant
- There was a better level of compliance with the immunity limits: 91.5% of the tested, forty-six (46) products were found to be compliant.

Within this market surveillance campaign an additional study on harmonic current emissions (EN61000-3-2) was carried out. When applying the same harmonic limits as those for compact fluorescent lamps, one out of two samples, 46% of the assessed LED lighting equipment failed. This is clear evidence for the need of a prompt amendment of EN61000-3-2.

Administrative compliance

The overall administrative compliance was only 28.8% and, mainly regarded the CE marking and the Declaration of Conformity (DoC) requirements.

Almost 9% of the assessed LED lighting equipment did not carry the CE marking, whereas almost 24% were either not CE marked or did not carry a correct CE marking (format and size) as required.

Declarations of Conformity were available for 125 (74.4%) of the assessed LED lighting equipment with almost half of them having major deficiencies (e.g. missing reference to the Directive, incorrect Directive, identification of the product, incorrect standards, not issued by the manufacturer and/or authorised representative, etc.). Overall, for 67 (39.9%) of these products an acceptable Declaration of Conformity was presented.

General

In general, the level of compliance of the LED lighting equipment with the technical and administrative requirements was considered insufficient. Overall, only 29 (17.3%) of the products were in line with both technical and administrative requirements. The assessment of the technical documentation and of the immunity requirements were performed on an optional basis, the results of this assessment have not been taken in account in the overall level of compliance. This means that the overall level of compliance could be lower if both requirements had been assessed.

(Taken from "Final Report on the 4th Joint Cross-Border EMC market Surveillance Campaign (2011), LED Lighting Products" by the EMC Administrative Co-operation Working Group, which can be downloaded from http://ec.europa.eu/enterprise/sectors/electrical/files/emc/ms-campaign-fourth_en.pdf. Also of interest, are: www.youtube.com/watch?v=-FNIM-jXUPc and www.emcrules.com/2011/07/radio-interference-from-led-lighting.html. Dinex Lighting reckon that their LED lighting has Zero EMI emissions: www.ioonline.net/ioonlinetest/dinexlighting.aspx, presumably because their luminaires are simply strings of LEDs, requiring external power control that will create

EMI emissions! The problem of emissions above 30MHz from modern lighting technologies was somewhat anticipated by: http://www.ofcom.org.uk/static/archive/ra/topics/research/topics/emc/8056cr2.pdf.)

755) Only 50% of consumer electronics sold in the EU complied with the EMC Directive in 2009/10

A total of 159 products were evaluated: 49 LCD televisions, 8 Plasma televisions, 39 Blu-Ray players and 63 DVD players.

Overall technical compliance with the requirements of the harmonised standards was low at 50%. For emissions only, 72% were compliant and for immunity only, 69% were compliant. There were wide variations in the level of compliance between products.

Declarations of Conformity (DoC) were obtainable for only 81% of products. Of these, only 80 % were correct, with 15% containing major deficiencies.

Compliance rates differed widely between tested product categories, ranging between 20 and 56%.

Blue-ray players (available mainly from major companies) score significantly better than DVD-players (large low-cost segment) both in technical and administrative compliance.

However, there is no similar tendency in the case of Plasma/LCD TVs.

The generally poor results for DVD players and for the immunity of plasma TVs have substantially reduced the overall compliance of all tested categories to 34%.

Country of origin could not be determined for 11% of the samples.

(Taken from: "Report on the Joint Cross-Border EMC Market Surveillance Campaign 2009/10 on Consumer Entertainment Electronics Products", the 3rd EMC Market Surveillance Campaign by the EMC Administrative Co-operation Working Group, which can be downloaded from: http://ec.europa.eu/enterprise/sectors/electrical/files/emc/ms-campaign-third_en.pdf.)

756) EMC Crime

It is becoming common worldwide for criminals to jam wireless datacomms in factories, bringing production to a halt. They only stop jamming when paid to. (There was a paper on this at Hanover EMC this year.)

(Kindly sent in by Dipl.-Ing. Werner Grommes, on 14 June 2012)

757) Disconnecting the battery to recover from EMI

I was testing a cellphone for immunity to EMI, it failed, but I was unable to recover normal functioning by switching it off and on – I had to remove its battery, then put it back in.

This is an increasing problem with cars, their microprocessors get into a state that can't be recovered from, and – as they are continuously powered (i.e. never off, just in standby) – the vehicle battery has to be disconnected to reset them properly.

(Kindly sent in by Dipl.-Ing. Werner Grommes, on 14 June 2012. Also see number 758 below.)

758) EMI flattens limousine batteries

The first CAN busses were installed in high-end automobiles ("limousines"), which were often to be found parked at airports.

EMI from the airport radars caused the CAN busses to wake up out of their standby (low current) mode (see Number 757 above), and because the radar swept over the car park about once every second the increased current demand from the awakened CAN busses flattened the battery very quickly.

(Told to the Editor by Wim Ophelders, Océ Technologies' SI and EMC expert, on November 8th 2012.Also see number 757 above.)

759) Cellphones interfere with photocopiers

When people with cellphones in their pockets operate photocopiers, it is sometimes found that the copier malfunctions.

(An anecdote told during the "Scitech" meeting of IEC TC62A MT23 (Medical Device EMC) held in Carlsbad, California, 19-23 March 2012. The generic and product immunity standards listed under the EMC Directive all exclude "the close proximity of mobile radio transmitters" and only test at 3V/m or 10V/m at cellphone frequencies, very much lower fields than a cellphone can create near to it. However, to test for close-proximity radio transmitters it is not enough to use far-field methods such as IEC 61000-4-3 and merely wind up the test level – because the ratio of the electric and magnetic fields is all wrong. This is why the Ford Motor Company and Schwarzbeck developed a near-field test suitable for simulating the close proximity of cellphones and other portable radio transmitters, which Ford added to their Component EMC Specification in 2009 (download ww.fordemc.com/docs/download/EMC_CS_2009rev1.pdf and read test method RI115), which is now being developed into ISO and IEC radiated immunity test methods – Editor.)

760) Lighting control system interferes with washing machine

One member described how their new washing machine suffers interference from his lightning control system. He has to switch both the lighting controller and washing machine off, then switch the washing machine on and get it washing, then he can turn the lighting controller back on again without upsetting the washing machine.

(Another anecdote told during the "Scitech" meeting of IEC TC62A MT23 (Medical Device EMC) held in Carlsbad, California, 19-23 March 2012.)

761) 5V/m measured at 2m below Hospital Emergency Room lights

These high field strengths – nearly double the immunity test level in the Medical EMC standard IEC 60601-1-2, all editions up to 3 – are said to often cause problems for ECGs (electrocardiograms – i.e. heart monitors) connected to patients who are under such lights.

The radiated noise spectrum from the lamps is below 30MHz, presumably caused by switched-mode lamp power controllers.

Dimmer controls also create EMI problems, it seems they are tested at their "full on" position – which is probably the least noisy setting – rather than tested at the worst-case emissions found over their operating range.

(Taken from a presentation describing a survey of the EM environments in three hospitals, by Hasnain Hassanali of Intertek Semko AB and Magnus Stridsman, at the "Scitech" meeting of IEC TC62A MT23 (Medical Device EMC) held in Carlsbad, California, 19-23 March 2012).

762) Proposed wireless broadband network may interfere with GPS Frequencies used to track hurricanes

In an effort to emerge from bankruptcy, wireless network company LightSquared Inc. has proposed a new plan for sharing radio signals utilized by weather facilities to accurately track storms like Hurricane Sandy. The new plan is salvaged from an earlier proposal for a satellite-based wireless broadband network that was blocked by the FCC over concern that it would interfere with global-positioning system navigation technology.

According to Peter Minnett, a professor of meteorology and physical oceanography at the University of Miami, the frequencies that LightSquared is interested in sharing are a "really important component of successful hurricane forecasting, responsible for producing the [satellite] imagery on all the TV broadcasts." A U.S. agency stated that frequencies used for weather forecasting should not be shared for wireless mobile services purposes due to the potential for interference, while weather forecasters are concerned that the public could be deprived of critical information if the frequencies are shared.

The company aims to begin offering limited high-speed data service over the radio signals it would share with weather facilities and increase use over a wider range of frequencies after the FCC develops a plan to avoid the interference concerns that stalled the wireless company's initial proposal.

(Taken from www.interferencetechnology.com/proposed-wireless-broadband-network-may-interfere-with-gps-frequencies-used-to-track-hurricanes/, 10/31/2012. For more information, see "LightSquared Looks to Airwaves Tracking Sandy for Revival" by Todd Shields and Tiffany Kary on October 29, 2012, in Bloomberg News: www.businessweek.com/news/2012-10-29/lightsquared-looks-to-airwaves-tracking-sandy-for-revival)

763) Research proves tin foil hats don't provide good RF shielding for your head

The longstanding mythology around the use of tin foil hats to block the government and extra-terrestrials from reading or controlling a person's thoughts using radio waves dates back to the late 1920s. The scientific logic is that the foil helmets act as a Faraday cage, an enclosure comprised of a conducting material that prevents external electrostatic charges and electromagnetic radiation from entering by distributing them around the exterior of the cage. However, the typical foil hat does not fully enclose a person's head as an effective Faraday cage would and is ineffective at blocking radio frequency electromagnetic radiation.

In 2005, a group of MIT students tested the effectiveness of foil helmets at blocking various radio frequencies by constructing three different helmet designs out of layers of aluminum foil.

Using a radio frequency signal generator and a receiver antenna placed on various parts of their subjects' heads, the students examined the strength of the transmissions.

The students discovered that though the helmets shielded the wearers from the majority of tested radio waves, they amplified certain frequencies, including those in the 2.6 GHz (allocated for mobile communications and broadcast satellites) and those in the 1.2 GHz (allocated for aeronautical radio-navigation) bands.

(Taken from www.interferencetechnology.com/research-proves-tin-foil-hats-do-prevent-increase-ease-of-mind-control/, 11/01/2012. For more information, visit The Atlantic, http://www.theatlantic.com/health/archive/2012/09/tin-foil-hats-actually-make-it-easier-for-the-government-to-track-your-thoughts/262998/. Please note that reading or controlling minds using radio frequencies is an urban myth that should not be taken seriously – however, this research shows that <u>if</u> it was possible (which it isn't!) wearing a tinfoil hat would only make it easier – Editor.)

764) Helicopter overflight triggers implanted defibrillator

A colleague in Norfolk is keen on football and together with a friend was watching a match in which his two boys were playing. Suddenly the friend was lifted violently up and backwards, falling on the grass well behind him, clutching his chest. Those who saw this collapse were sure he had been shot. He had not been shot, but his cardiac defibrillator had gone into overdrive for some reason. Why? The football pitch was near an RAF base in Norfolk - a MATZ where both planes and helicopters were stationed. The football ground was under the flight path, and a helicopter was flying overhead at just that moment. This happened to the same person on two occasions, both of them seen by my colleague. Cardiologists found nothing wrong with him.

We should not be surprised at this effect as for many years cardiologists have been drawing attention to the effects of magnets and magnetic fields on pacemakers. A most important Editorial was written by Krit Jongnarangsin in the journal 'Heart Rhythm' in 2009. His team at the University of Michigan also drew attention to the hazards of commercially available Neodymium magnets. Jewellery and objects that contain this type of magnet can be inadvertently placed over an implanted device and may cause interaction. In trials, all 41 patients with pacemakers and 29 with ICDs experienced interference when neodymium magnets were placed only 3 cms from the implanted device.

(Kindly sent in by Anne Silk on 25th February 2013.)

765) EMI to airbags causes Toyota to recall over 1 million vehicles

Toyota has recalled more than 1 million Corolla, Corolla Matrix and Pontiac Vibe models across the globe due to faulty air bags that could deploy accidentally without warning.

According to a "defect information report" submitted to the National Highway Traffic Safety Administration (NHTSA) by Toyota, the air bag control module can experience a short circuit "when exposed to high inductive electrical noise from various vehicle electrical components."

Toyota has confirmed 18 U.S. cases of abrasion-type injuries resulting from the faulty air bag deployment. Two accidents have also been reported by customers in Japan, but Toyota has not confirmed the authenticity of the reports.

Toyota plans to add a filter to the airbag control module in all recalled vehicles to prevent interference.

(Taken from: Interference Technology's on-line news report, www.interferencetechnology.com/toyota-issues-vehicle-recall-due-to-electrical-interference/, 02/01/2013. For more information visit the New York Times: http://wheels.blogs.nytimes.com/2013/01/30/toyota-recalling-1-million-vehicles-for-air-bag-and-wiper-problems/?ref=automobiles, January 30, 2013, 11:11am; and the NHTSA: http://www-odi.nhtsa.dot.gov/owners/SearchResults.action?searchType=ID&targetCategory=R&searchCriteria.nhtsa_ids=13V029&refurl=email.)

766) Passenger electronics cause flight changes

Disturbances of flight instruments causing trajectory deviations appear when one or several passengers switch on electronic devices.

FAA Aviation Safety Reporting System has reported 12 cases of interference in aircraft due to personal electronic devices since 2002.

(Taken from "EMC Part3 measurement methods Oct12" by Alexandre Boyer, http://www.alexandre-boyer.fr/alex/enseignement/EMC_Part3_measurement_methods_Oct12.ppt. Alexandre reports the first sentence as being originally published in "Air et Cosmos", April 1993.)

767) Vacuum cleaner interferes with Spacelab

During a Spacelab mission in 1985, the crew decided to use the middeck vacuum cleaner instead of the one in the lab. Switching the middeck vacuum on caused the voltage to drop and the Remote Acquisition Unit to shut off. In preflight EMI tests, the vacuum cleaner had not been tested and should not have been used in the lab. This case shows how careful and attentive one must when dealing with EMC.

(Copied from NASA Reference Publication 1374 "Electronic Systems Failures and Anomalies Attributed to Electromagnetic Interference", by R.D Leach and M. B Alenxander, Editor, available from: http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19960009442_1996109442.pdf, and also from: http://www.cvel.clemson.edu/pdf/nasa-rp1374.pdf)

768) 50 billion Machine-to-Machine (M2M) cellphones by 2020

Developer Community: Ideas catalyst for M2M developers

Q: Why is Deutsche Telekom placing so much emphasis on M2M innovation?

A: We are convinced that the M2M market will boom over the coming years. According to information from the OECD, the number of networked machines will rise to approximately 50 billion in 2020.

(Taken from: Connectingindustry.com/electronics, September 2012. The answer was attributed to Jurgen Hase, Head of Deustche Telecom's M2M Competence Centre. Editor's note: *M2M essentially means cellphones embedded in items of equipment to provide them with full-time datacommunications, and 50 billion of them are going to make a considerable addition to the noise in the EM environment.)*

769) Neutron susceptibility of chips used in avionics

In addition, when designing systems, engineers could look at building in greater redundancy and being more selective with components. Research has shown that microprocessor chips vary in their neutron susceptibility by up to 10-fold.

"The tricky thing is that manufacturers can change their processes quite a lot without avionics engineers even knowing about it; electrically they'll do the same function but from this point of view [neutron susceptibility] they change quite dramatically.", said Ryden.

(Taken from: "Weather Warnings, Quinetiq gauges effects of storms on airliners", by Andrew Czyzewski, in The Engineer, Aerospace Special, October 2012, page 6, www.theengineer.co.uk.)

770) ESD effects on oscilloscopes – time goes backwards!

When debugging designs or making electrical measurements of noise, especially ESD, we often assume the only equipment in the room that works perfectly is our measurement equipment. This assumption can be wrong and when it is, the bad data that results can add significantly to the time needed to get to the cause of a design problem. Examples of ESD interference to oscilloscopes are described and one innovative approach to minimizing EMI induced error is shown.

Figure 1 shows an attempt to measure a waveform associated with an ESD event using a high bandwidth analog scope many years ago. Almost every engineer or technician trying to make such a measurement in that time frame obtained a plot like Figure 1. The plot was taken using a 1 GHz bandwidth Tektronix 7104 analog scope with a camera mounted on the scope to capture the waveform. The 7104 was the last of the analog scopes in general use just before digital scopes became fast enough to take over most lab measurements.

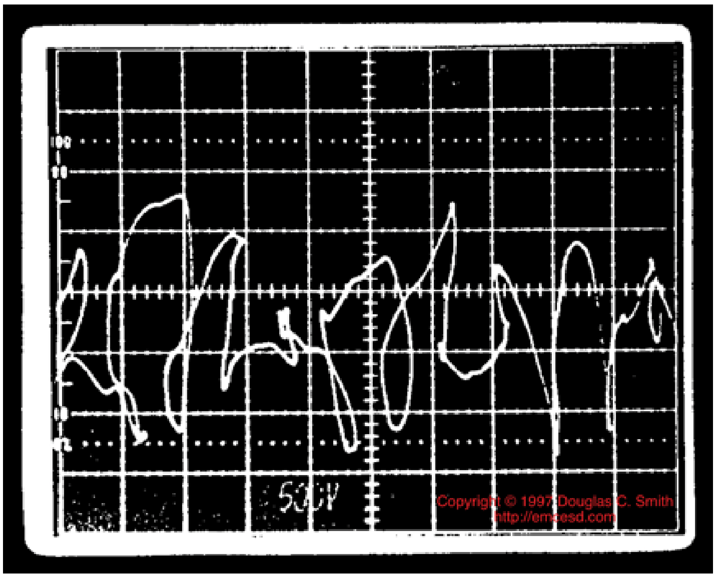


Figure 1: Example of ESD Induced Error in an Analog Oscilloscope

In the plot of Figure 1, time appears to go backwards! What really happened was that the very strong fields generated by the ESD simulator interacted directly with the electron beam in the oscilloscope, overriding what the scope deflection systems were trying to do. The result drove the electron beam all over the screen, resulting in the strange waveform in the figure. People quickly learned to put these scopes in a Faraday Cage when making ESD measurements. The Faraday Cage shielded the scope from the ESD generated fields, and the desired waveform was obtained.

These days we use digital scopes with solid state displays that don't use electron beams the way analog scopes did, but it is still possible to get EMI induced error in scope measurements. One example can be seen in my Technical Tidbit article September 2004, Mobile Phone Response to EMI from Small Metal ESD. One of the figures from that article is reproduced in Figure 2.

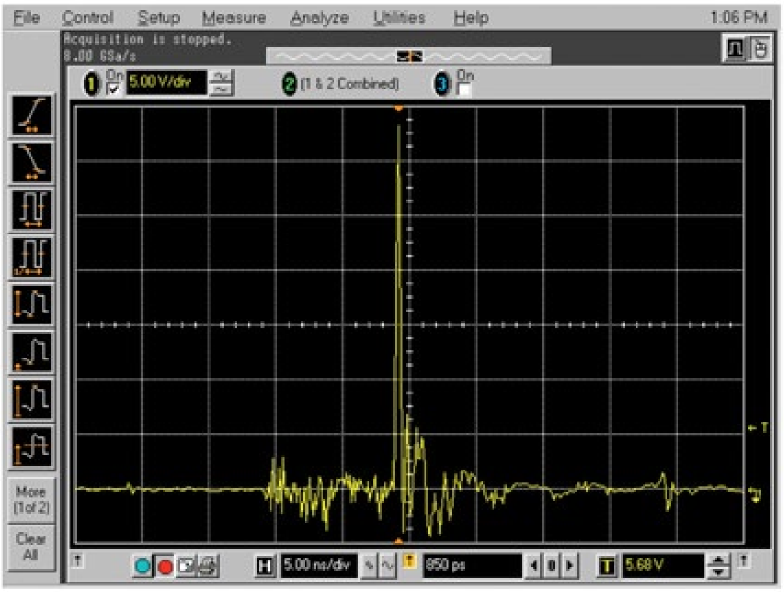


Figure 2: Example of ESD Induced Error in a Digital Oscilloscope

(Vertical scale = 5 Volts/div, Horizontal scale = 5 ns/div)

The plot in Figure 2 was the voltage induced into a small dipole antenna tuned to about 1800 MHz in response to jingling coins in a plastic bag. The desired signal is the tall spike in the middle of the plot. But notice the "hash" noise starting about 10 ns before the spike. This noise traveled over the direct path through the air from the ESD events into the scope electronics.

The hash starts earlier because the propagation time is faster for the air path than through several feet of coax cable the desired signal had to travel through. To fix this and similar problems one can use a

Faraday Cage around the scope or simply move the scope further away from the source of the EMI, jingling coins in this case.

Figure 3 shows one solution by a friend of mine, Jon Barth of Barth Electronics in Boulder City, NV, to the problem of ESD interference to his scope and PC while trying to measure the calibration waveform of an ESD simulator.

ESD noise was getting into the connection between his PC and the scope, making data acquisition nearly impossible.

The copper tape and aluminum foil shield did the job for him and is much simpler to implement quickly than a Faraday Cage.

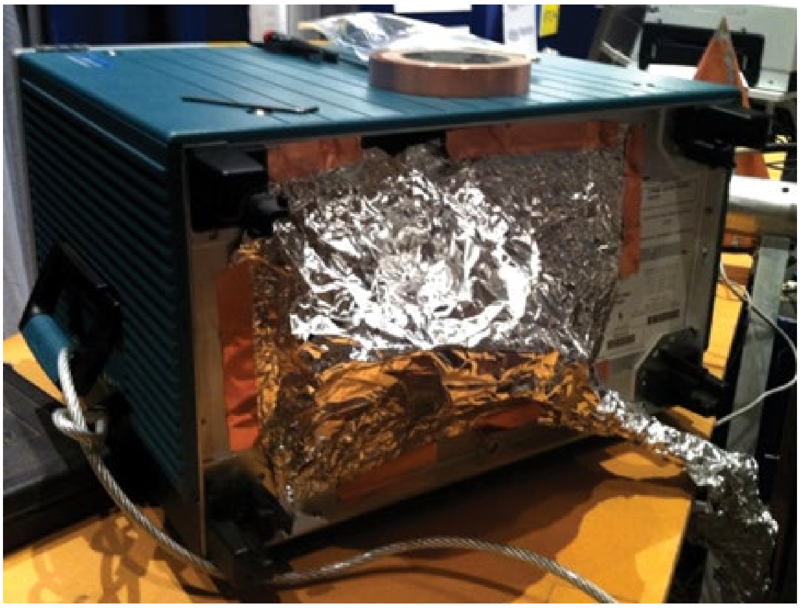


Figure 3: Makeshift Shield to Prevent ESD Induced Measurement Error

EMI can manifest itself in other ways as well including crosstalk between scope channels when trying to measure a high amplitude signal and a small one on different channels at the same time. I have even seen, back in the early 1990s, a scope change its state because its control circuits were not immune to the effects of ESD. The results of this problem were quite evident though so there is little danger of bad data from this cause.

The effects of EMI on analog and digital scopes are quite different, but in both cases, significant measurement error can occur if care is not taken.

Don’t assume your measurement equipment is working perfectly, especially around ESD. Be on the lookout for error creeping into your measurements.

(Taken from: “Electromagnetic Interference (EMI) Effects on Measurement Equipment - ESD Effects on Oscilloscopes”, by Douglas C. Smith, in Incompliance Magazine, Nov 2012, http://www.incompliancemag.com/index.php?option=com_content&view=article&id=1251:electromagnetic-interference-emi-effects-on-measurement-equipment-esd-effects-on-oscilloscopes&catid=71:technical-tidbits&Itemid=215. For more Technical Tidbits, please visit Doug’s site, http://emesd.com.)

771) Lightning interferes with high-speed trains, killing 40 and injuring 191

Forty people died and 191 were injured in the crash near Wenzhou, on a high-speed line connecting cities along the south-east coast. A train that had stalled on a viaduct after losing power in a lightning strike was hit from behind by another. Some coaches plunged from the bridge to the ground below.

The head of Shanghai Railway Bureau, An Lusheng, said the signalling system at Wenzhou South failed to turn the green light to red, after it was struck by lightning. He failed to explain why the second train was not warned that there was a stalled train in its path or whether the system had a back-up to automatically issue a warning to stop in such situations.

(Taken from “China backpedals on high-speed rail expansion plans” by William Dennis, in Engineering & Technology magazine, Sep 2011, page 16, www.EandTmagazine.com.)

772) EMI may stop people from using their cars

As cars feature more and more electronics, EMC testing is becoming more stringent.

But while there is an understandable focus on the electronics which control the car, spare a thought for the humble key fob. “It’s going to be an area where there will be much more testing,” he concluded. “There’s so much going on in the 433MHz band that people may not be able to get into their cars because of all the interference.”

(Taken from “Eliminating interference”, by Graham Pitcher, in New Electronics magazine, 27 Sep 2011, pages 21-22, www.newelectronics.co.uk.)

773) TV switch-over triggers rush to see emissions from rare stars

US skies are clearer than usual after the switch in June from analogue to digital TV freed up a chunk of the radio spectrum. Astronomers are now rushing to see what they can find before transmissions from cellphone companies and others fill the space.

Prior to the switch-over, naturally occurring radio waves at frequencies between 700 and 800 megahertz were obscured by analogue TV signals, preventing astronomers from investigating the universe using this band. Now a receiver has been installed at the Arecibo Observatory in Puerto Rico to take advantage of the new-found clarity.

The window is giving astronomers their first radio views of galaxies that thrived when the universe was about half its present age. They hope to measure how much hydrogen – the raw material for new stars – the galaxies had. "It's a once-in-a-lifetime opportunity to see galaxies in that range," says Arecibo researcher Chris Salter. "We're able to see an epoch that hasn't been observed before with radio eyes."

The new window may also help in the hunt for pulsars – neutron stars that emit beams of radio waves from their poles. In this part of the spectrum, their beams are less impeded by interstellar electrons, which can scatter radio waves.

This boosts the chances of spotting rare examples of these stars. "We're looking for pulsar exotica," says Duncan Lorimer of West Virginia University in Morgantown. He and his colleague Mitch Mickaliger are hoping to find a pulsar orbiting a black hole, as as-yet-undiscovered pairing that could be used to test general relativity.

This radio window won't be open for long, though. Much of the new band has already been auctioned off, and astronomers at Arecibo might only get a year of clear skies, says Donald Campbell of Cornell University in Ithca, New York.

(Taken from: "TV switch-over triggers rush to see rare stars" by Rachel Courtland, in New Scientist, 7 Nov 2009, www.newscientist.com.)

774) Spacecraft EMC – "Traditional Anomalies"

During the first Space Shuttle mission (STS-88) to the International Space Station, VHF transmissions from ground stations interfered with radio communications of crew performing extravehicular activities.

(Taken from: "Space Environmental Effects and Spacecraft EMC", by Matthew McCollum, NASA, Marshall Space Flight Center, http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20040120952_2004116614.pdf)

775) Marine radio transmissions stop traffic

Boat owners in Dartmouth made themselves very unpopular with motorists in November. Every time they broadcast on marine radio, it caused a set of temporary traffic lights on North Embankment Road to reset to red in both directions, causing massive traffic jams. Engineers had to be called to manually restore the lights each time it happened. So power does give way to sail, after all.

(Taken from: "The power of radio", in the Bosun's Bag column on page 168 of Practical Boat Owner, Issue 483, March 2007, which was very kindly sent in by Harold Smart of Harold Smart & Associates, on 27 September 2007.)

776) Backwards resistor acts as antenna, picks up EMI

However, most of the boards that had failed in testing seemed to be fully operational, but had excess noise. In examining signals on all the nodes throughout the circuit, everything looked normal, but the meter readout was unstable. Although its mean reading was correct, it erratically jumped around. I examined the circuit operation, then looked at the defective board alongside one that was working properly. Then I saw it: a resistor installed backwards.

To minimize board space, the assemblers mounted the resistors – mostly axial-leaded 1/8W resistors – on the board standing up. The first amplifier stage had two resistors to set its gain. The resistor going from the negative input of the amplifier to ground had been assembled with the lead going to the amplifier input facing into the air. In this configuration, the lead became an antenna that allowed the injection of interference directly into the input of the first amplifier stage – the source of the excess noise.

We inspected the rest of the amplifier boards; most had the resistor in backward. We added a note to the board's test procedure to carefully check the position of this resistor before beginning the electrical tests.

(Taken from "The eyes have it", by Jerome Jonston, in Tales From The Cube, EDN Europe. July 2007, www.edn-europe.com.)

777) Class D audio amplifiers and EMI

Class D amplifiers are frequently referred to as digital amplifiers, but some designs are better described as switching amplifiers. They essentially consist of a switch-mode power supply, supplying current into the load (loudspeaker) under the control of the audio input waveform, with the output being low-pass filtered in a similar manner to digital-to-analogue converters.

In self-powered loudspeakers they can find willing partners because of their small size, low cost, and low heat generation. However, they still can be prone to the emission of troublesome electromagnetic interference (EMI) because of the high switching frequency used, (and the whole concept of switching itself). Of course, they all must meet current electromagnetic compatibility (EMC) regulations, just like the office fax machine and digital radio/alarm clock but, as this is being written, those devices must often be switched off in order to clearly hear the BBC World Service on a small portable radio.

Fast switching always generates harmonics into the megahertz regions, and such emissions have a great potential to interfere with nearby electronic equipment. In other words, compliance with EMC regulations is one thing, but being a good neighbour with the rest of the sensitive equipment in a recording studio is another thing. This is especially so when 'vintage' equipment is in use, designed before there was a need to even think about digital switching transients. Nevertheless, as times goes on, improvements will be made, and Class D amplifiers are steadily progressing.

(Taken from: "Loudspeakers: Effects of amplifiers and cables – Part 3", by Philip Newell and Keith Holland, in Audio DesignLine, www.eetimes.com/design/audio-design/4015819/Loudspeakers-Effects-of-amplifiers-and-cables--Part-3, 5 September 2007.)

778) Loudspeaker cables as antennas, injecting noise into audio amplifiers

RFI: can be very important; if you spectrum analyse (I work up to 1.5 GHz) the dominant RFI is about 1 MHz for many loudspeaker cables. Many amplifiers are no longer anything you would recognise by 100 KHz, never mind the 1 MHz, and the RF gets in the output terminals and intermodulates around the feedback loop. A speaker cable is often a good medium-wave aerial.

Cables vary greatly in how they dump RF interference into the amplifier output port. The Zobel filter has little effect as it is generally buffered by 10 ohms. If the RFI doesn't get in the positive line, it common modes the ground line.

At 1 MHz or more, the RFI hardly cares what kind of amplifier it is.

(Taken from a quotation by Martin Colloms in "Loudspeakers: Effects of amplifiers and cables – Part 6", by Philip Newell and Keith Holland, in Audio DesignLine, http://www.eetimes.com/design/audio-design/4015822/Loudspeakers-Effects-of-amplifiers-and-cables--Part-6, 26 September 2007.)

779) Devastating HERO problems in the US Navy

(HERO is the US military acronym for Hazards of Electromagnetic Radiation to Ordnance, and of course "ordnance" is essentially bombs and missiles, which these days are all electronically fused, making EMC a rather important issue! – Editor.)

Harry Gaul reports that all had an exciting time at the February 19th IEEE EMC Society Phoenix Chapter meeting held at the Marriott Mountain Shadows in Scottsdale. Mike Hatfield of the Naval Surface Warfare Center Dahlgren Division gave a presentation on reverberation chambers.

Mike spoke on "How to conduct electromagnetic effects testing using a microwave oven and a pair of dice, or, a statistical approach for conducting system electromagnetic vulnerability assessments." Mike began his talk with a short history of actual devastating HERO problems in the Navy followed by an in-depth look at the statistical basis for repeatability in mode-tuned chambers as a function of the number of tuner positions.

(Taken from the IEEE EMC Society newsletter, issue 201, Spring 04, page 18, www.emcs.org/acstrial/newsletters/spring04/index.html. Information on future meetings of the Phoenix EMC Chapter is available from their website: www.ewh.ieee.org/r6/phoenix/phoenixemc/. For more information on HERO and other military RADHAZ (radiation hazards) issues, visit http://www.phys.hawaii.edu/~anita/new/papers/militaryHandbook/radhaz.pdf.)

780) The energy-saving LED bulb that switched off the radio

We get sent some weird and wonderful tales of products going wrong, but one story piqued our interest so much that we just had to send it to the lab to test it out. Can you help us shed more light on the mystery?

Last year we received this intriguing message: ‘I recently changed six halogen down-lighters to more energy efficient LED bulbs. Unfortunately when the lights were switched on, the DAB signal on my radio was wiped out!’

To try and figure out this conundrum, we sent a batch of cheap, generic 12V LED bulbs to our lab and found that when a digital radio was placed within a few metres of the switched-on bulbs the signal went fuzzy. When the radio was placed within a few centimetres of the LED bulbs, it cut out all together.

The plot thickens

LEDs are ultra energy efficient light bulbs that can last up to twenty years and have been hailed as the future of home lighting.

It seems our members are not the only ones who have had this problem. There are other accounts of LED bulbs affecting radios, with AVForums also collecting stories. Nick Tooley shared his experience: ‘I had the same problems with LED bulbs wiping out DAB reception and tried several types of bulbs, but to no avail.’

And it seems that the issue may not just be limited to digital radios – TVs may also be affected. After fitting LED down-lighters in his kitchen, Jackord noticed the following problem: ‘While the lights are much better, we then by accident noticed that the digital TV would not work (I was complaining that we had no reception at all, did not make any sense, began to think that there had been some sort of catastrophic disaster which stopped the TV stations from broadcasting…lol) then someone turned off the ceiling lights in the kitchen and, hey presto, on came the TV.’

(Taken from “The energy-saving LED bulb that switched off the radio” by Becky Pritchard, Senior Home Researcher, Energy & Home section, Which? Magazine, 17 March 2013, http://conversation.which.co.uk/energy-home/led-bulb-radio-interference-dab-test, kindly sent in by long-term “Banana Skinner” Graham Eckersall. There is a lot of official activity on the issue of EMI from LED lamps, in which the EMCIA is heavily involved, www.emcia.org.)

781) French Fashion Label to Debut Electromagnetic Wave-Blocking Menswear

A French fashion label has announced the upcoming release of men’s suits reportedly capable of blocking electromagnetic waves produced by cell phones and other portable electronic devices.

“This is the first [commercial] use of technological materials in everyday men’s clothing that doesn’t cause discomfort,” Benjamin Anin of Smuggler’s research and development department said.

“Until now, this type of very specific material was more rudimentary and only used by certain professionals who were particularly exposed.”

A French fashion label has announced the upcoming release of men’s suits reportedly capable of blocking electromagnetic waves produced by cell phones and other portable electronic devices.

(Image: Smuggler)

According to the company, the new material took three years to develop and is comprised of fabric interwoven with non-allergenic nickel, stainless steel, aluminum and faux gold. The material was developed in collaboration with the XLIM Institute in Limoges, France and is reportedly capable of blocking 90 percent of electromagnetic waves emitted by portable electronic devices.

The material will make its debut as part of Smuggler's spring-summer 2013 collection.

(Taken from an article with the same title, written by Aliza Becker, 03/21/2013, published in Interference Technology's on-line newsletter, www.interferencetechnology.com/french-fashion-label-to-debut-electromagnetic-wave-blocking-menswear/. For more information, visit Expatica: www.expatica.com/fr/news/french-news/french-fashion-firm-develops-suit-that-blocks-electromagnetic-waves_261681.html.)

782) "World's First" Automatic GPS Backup Demonstrated in Maritime Jamming Trial

The ACCSEAS, a European Union part-funded project involving 11 partners from the North Sea Region, announced this month that technology designed to automatically counter the threat of GPS jamming in maritime shipping and transport vessels has been successfully demonstrated for the first time.

The new counter-jamming technology employs eLoran, an extension of the LORAN technology developed by U.S. scientists that enables ships and aircraft to determine their speed and location from low frequency radio signals transmitted by fixed land-based radio beacons.

The ACCSEAS, a European Union part-funded project, announced this month that technology designed to automatically counter the threat of GPS jamming in maritime shipping and transport vessels has been successfully demonstrated for the first time.

(Image: Vichaya Kiatying-Angsulee / FreeDigitalPhotos.net)

According to ACCSEAS, during a series of tests aboard the THV Galatea sailing out of Harwich, UK, a "prototype resilient PNT (positioning, navigation and timing) system" demonstrated the capability to automatically switch over from GPS to eLoran without interruption when presented with interference, enabling the ship to continue as normal. This latest trial was built upon results collected by two previous trials conducted by the General Lighthouse Authorities (GLA) in 2008 and 2010, which examined the impact of GPS service denial.

The success of the European Union's trial comes at a point in time where the unauthorized use of inexpensive jamming devices continues to grow, while maritime navigation systems continue to rely increasingly on GPS satellites for accurate and safe navigation.

A separate, 24-month study recently launched by the UK government identified more than 60 instances of GPS jamming equipment in passing vehicles over a period of six months using roadside monitoring systems. Other research also identified the potential of interference from developing windfarms along the coastlines with maritime navigation systems. While interference poses a minor problem for average users who may temporarily lose the ability to access turn-by-turn driving directions or satellite map applications, the potential impact is much more serious and potentially life-threatening to the aerospace and maritime industries.

However, despite the increase in identified jamming cases, no one really knows how much GPS jamming is happening, David Last of the General Lighthouse Authorities, one of the partners in the ACCSEAS project, told TechWeekEurope.

"As far as we can see, in the UK at the moment it's mostly individuals using the so-called 'personal privacy devices.' If you're a white van driver and want to do a bit of moonlighting,' but your company installs tracking systems in its fleet, you buy one of these things, plug it in the cigarette lighter socket, and it jams GPS in the vehicle and a certain distance around it," he said.

Martyn Thomas, vice president of the Royal Academy of Engineering, believes it is important to continue to strengthen GPS anti-jamming capabilities for the future in general, regardless of where issues with jamming equipment are appearing now.

“GPS and other satellite navigation systems are deeply embedded in several critical sectors such as telecommunications, power distribution and high frequency financial trading, in addition to transport,” he said. “The dangerous over reliance on GPS makes it a potential common point of failure for very many systems, so any technology that can provide resilience to these systems should be welcomed across the board.”

(Taken from an article with the same title, written by Aliza Becker, 03/20/2013, published in Interference Technology’s on-line newsletter,www.interferencetechnology.com/worlds-first-automatic-gps-backup-demonstrated-in-maritime-jamming-trial. For more information, visit ACCSEAS (http://www.accseas.eu) and Tech Week Europe: www.techweekeurope.co.uk/interview/gps-jamming-eloran-failover-109868.)

783) Subaru cars that can gas people due to remote engine starter damage

This letter serves to acknowledge Subaru of America, Inc.'s notification to the National Highway Traffic Safety Administration (NHTSA) of a safety recall which will be conducted pursuant to Federal law for the product(s) listed below. Please review the following information to ensure that it conforms to your records as this information is being made available to the public. If the information does not agree with your records, please contact us immediately to discuss your concerns.

Makes/Models/Model Years:

SUBARU/IMPREZA/2012-2013	SUBARU/LEGACY/2010-2013
SUBARU/OUTBACK/2010-2013	SUBARU/XV CROSSTREK/2013
Mfr's Report Date: February 22, 2013	NHTSA Campaign Number: 13V-061

Components:

ELECTRICAL SYSTEM, EQUIPMENT

Potential Number of Units Affected: 47,419

Problem Description:

Subaru is recalling certain model year 2010-2012 Legacy and Outback vehicles equipped with an automatic or CVT transmission and an Audiovox remote engine starter (RES) accessory, certain model year 2012-2013 Impreza vehicles equipped with a CVT transmission and an Audiovox remote engine starter (RES) accessory, and certain model year 2013 XV Crosstrek vehicles equipped with a CVT transmission and an Audiovox remote engine starter (RES) accessory.

Additionally included are certain model year 2013 Legacy and Outback vehicles that may have received replacement RES fobs.

If the RES fob is dropped, the fob may malfunction and randomly transmit an engine start request without pressing the button.

Consequence:

The engine may inadvertently start and run for up to fifteen minutes. The engine may continue to start and stop until the fob battery is depleted, or until the vehicle runs out of fuel. If the vehicle is parked in an enclosed area, there is a risk of carbon monoxide buildup which may cause headaches, dizziness or, in extreme cases, unconsciousness and/or asphyxiation.

Remedy:

Subaru will notify owners, and dealers will replace the RES key fobs, free of charge. The recall is expected to begin by the end of April 2013. Owners may contact Subaru at 1-800-782-2783 for more information.

Notes:

Original equipment keyless entry fobs integrated on the vehicle key are not affected. Subaru's recall campaign number is WQF-42.

(Taken from a letter from NHTSA to Subaru America, Inc., dated March 7, 2013, at http://www-odi.nhtsa.dot.gov/acms/cs/jaxrs/download/doc/UCM434360/RCAK-13V061-5804.PDF. Kindly sent in by Brian Kirk on 19th March 2013, who saw an article about it on the CNN Money programme on the 17th March.)

784) An EMI fixer's tale

A few years ago, when I had recently joined a high-speed test equipment manufacturer, I was assigned to take a production-ready (and very promising) product through EMI scans. The product needed to undergo EMI compliance testing before being shipped.

This product, which was housed in a rack-mount 8U metal chassis, consisted of a control card, a communication card, and several line cards. Micro coaxial cables connected internal high-speed circuitry to external ICs under test.

Since this was not my design, I prepared for the EMI scans by studying the schematics, the layout of the boards and the backplane, the mechanical aspects of the chassis, and the seating of cards in the chassis for possible areas of EMI leakage. The product was designed to test ICs at several hundred megahertz and to capture the outputs of ICs containing hundreds of pins at 5-psec timing resolution. As a result, the line cards were full of high-precision clock circuitry, high-speed/low-skew clock and pin drivers, and high-speed ADCs and DACs.

One thing that stood out was that the product was not well-designed for passing EMI emissions test. The power-supply filtering on the line cards was highly inadequate, and the grounding was multi-point, with the entire front side of the chassis connected to signal_ground at different points on each line card. It was apparent that my EMI scan was going to involve a long fight.

An EMI pre-scan proved my suspicions. Radiated emissions exceeded FCC Class A requirements by 10 to 12 dB at various frequencies in the range 100 MHz through 1.5 GHz.

I tried the usual fixes—plugged and unplugged several line cards and cables, added ferrite clamps to power and other slower cables, wrapped high-speed input/output (I/O) cables around ferrites, and so forth—but none of these actions made any significant difference. I added more filtering to clock oscillators and drivers and changed single-stage filters to twostage cascaded filters, and something interesting started to happen. As I doubled the filter stages, EMI levels would go down at some frequencies but shoot up at some other frequencies.

It got very frustrating and I spent several days and late nights in the EMI test lab trying to catch this moving target. When I attached long, hanging wires to the chassis to act as antennas, I saw no difference in electromagnetic radiation. It was possible that the entire chassis was somehow acting as one big antenna.

I knew that high-speed currents from multiple signal_ground connections were flowing along the front edge of the chassis. But why would they circulate all over the chassis instead of following the path of least impedance?

I removed all line cards and opened up the chassis. I noticed that the chassis and signal_ground of the backplane were shorted together even when no line cards were present.

Then I took out the plug-in power modules one at a time. There were two of them, one on either side of the chassis, plugged in from the back. When I took out both, the short between chassis and signal_ground was gone. This had to have serious EMI implications.

The two power modules were shorting the signal_ground to the chassis at two ends of the chassis that were 16 inches apart, near the backplane power connectors. The high-speed return currents in the signal_ground of the backplane were free to circulate not just along the front edge of the chassis but also along the back edge, or effectively throughout the entire chassis. The chassis had become an antenna and was radiating instead of shielding the internal circuitry.

Opening up a power module showed the cause of this. Return for 12V power (also the signal_ground for the backplane) was electrically attached to the inside of the metal housing of the power module. I disconnected these returns and plugged the power modules back in.

There were no more shorts.

A subsequent EMI scan showed that the offending emissions were now down from 12 dB to 4 dB for all frequencies in the spectrum. My job was not over yet, but this was a good start.

Over the next few days, I was able to reduce the EMI for a partially populated system down to acceptable limits.

(Taken from "Tracking a moving target" by Anoop Hegde, in Tales From the Cube, in EDN magazine, February 27, 2013, www.edn.com/electronics-blogs/tales-from-the-cube/4406439/Tracking-a-moving-target.)

785) Black Hawk helicopter EMC/RFI susceptibility

The cover story of the IEEE EMC Society Newsletter of Winter 1988, Issue Number 136, was titled "EMC Makes Headlines". The story was about the U.S. Army's UH-60 Black Hawk heliucopter and itys susceptibility to EMI/RFI. The Knight-Ridder News Service broke the story in November of 1987 based on a three-month investigation.

The story presented strong evidence that most, if not all, of the sudden crashes that have killed 22 servicemen since 1982 were caused by flying close to radar antennas, radio or microwave towers, and in one case, an illegal CB transmitter.

Black Hawk's electronically-controlled flight control system, as well as much of the rest of its avionics, was said to be both susceptible to EMCI/RFI and inadequately shielded.

The Navy version of the UH-60, the Sea Hawk, was reported to have suffered from the same condition until the Navy required the contractor, Sikorsky Aircraft Company, to provide greater shielding of the Navy models.

Follow-up stories several days later reported that the Army is now requiring that all future Black Hawk logic modules be shielded like the Navy version and old modules replaced.

(Taken from "EMC Society History" by Daniel D. Hoolihan, Associate Editor, Chair of the EMC Society History Committee, in the 2013 IEEE Electromagnetic Compatibility Magazine, Volume 2, Quarter 1, http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6512214.)

786) Smart Grid interference problems in Sweden

Examples of lack of EMC in relation to evolving smart grid technologies have been reported in Sweden.

Kilowatt-hour meters in households sending data signals through power lines have caused interference with, for example, dimmer controlled lamps and electrical appliances.

There are also cases reported where electrical apparatuses in households have interfered with electronic kilowatt-hour meters with adverse errors in registration of energy. *(But adverse for who? – Editor.)*

Power electronics in wind power plants have emitted disturbances interfering with transfer of kilowatt-hour meter readings as signals on power lines.

(Taken from the Chapter entitled "Field Experiences with Smart Grid Technology" in the article "Low Frequency EMC and Power Quality", by Dr Magnus Olofssun, in In Compliance Magazine's 2013 Annual Guide, page 93, www.incompliancemag.com.)

787) Conducted emissions from HVAC motor drives cause false MRI Scanner readings

Conducted emissions (CE) are currents that travel on circuit wiring or conductive portions of assemblies and structures. For example, noise from a vehicle alternator is conducted along primary vehicle wiring to radio thus affecting radio performance. CE may also be due to conductive chassis as electrical paths (sometimes unintentional). Example – parasitic capacitance between a switching transistor and heat sink completes current path resulting in CE current. Depending on the wiring length and frequency of CE noise, this may result in a radiated emission as well.

A deviation type of CE and can occur due to the use of various types of electromechanical devices (solenoid relays). For example, variable frequency electric drives (VFD) were installed on a HVAC system in a renovation of an older medical facility. During the renovation, MRI machines were also installed.

False readings from the MRI machines were then taken by medical personnel. The quickest solution was to install a separate electrical service for the MRI machines.

(Taken from "Chapter Chatter, Rock River Valley", compiled by Todd Robinson, in the 2013 IEEE Electromagnetic Compatibility Magazine, Volume 2, Quarter 1, http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6512209.)

788) New US Defense radios interfered with tens of thousands of garage-door openers

The military's main concern was interference. Microstimulators would have to operate in the same spectrum as high-power defense systems. "We're talking about megawatt radars," says Fred Moorefield, who was IRAC's Air Force representative and the main liaison between the Alfred Mann Foundation and the military.

No one worried, he says, about one-milliwatt microstimulators wiping out the military's air-defense system. Rather, the scenario Moorefield and others feared most was that the radars would disable the microstimulators, with the disastrous outcome of both injuring patients and inciting empathetic lawmakers to kick the military out of the band.

At the time, the military was facing a watered-down version of this very issue: Since their rollout began in 2004, new defense radios had reportedly impaired tens of thousands of garage-door openers, which used some of the military's spectrum on a secondary basis.

(Taken from "Peaceful Coexistence – The trials of a small team of engineers who set out to reanimate paralyzed limbs demonstrate the virtues of dynamic spectrum sharing", by Ariel Bleicher, in IEEE Spectrum (International Edition) April 2013, http://spectrum.ieee.org/telecom/wireless/peaceful-coexistence-on-the-radio-spectrum.)

789) Electric and hybrid vehicle chargers interfere with pacemakers

On 19th March, 2013, the Japan Ministry of Health, Labour and Welfare issued a notice about possible malfunction of pacemakers and ICDs near chargers for electric vehicles (EV) and plug-in hybrid vehicles (PHV).

A summary of the experiment was reported in the Pharmaceuticals and Medical Devices Safety Information No. 302 issued in June 2013.

25 models of implantable cardiac pacemakers and implantable cardioverter-defibrillators (ICDs) were tested with slow chargers (Mode 2 and Mode 3) and a fast charger for EVs/PHVs.

In the experiment, when those pacemakers/ICDs were set to single-pole detection mode, 12 models of tested 25 models of pacemakers/ICDs were affected near the fast charger and 10 models of tested 25 models were affected near each of the slow chargers.

The maximum distance where effects to the pacemakers/ICDs were observed were 53cm for the fast charger, and 12.5cm and 7.5cm for the Mode 2 and Mode 3 slow chargers respectively.

When those pacemakers/ICDs were set to two-pole detection mode, 2 models were affected near the Mode 2 slow charger. The effects observed include inhibition of pacing pulses and generation of unexpected pacing pulses. The observed effects diminished when the pacemakers/ICDs were moved away from the chargers.

With the notice, users of pacemakers/ICDs will be advised not to use fast chargers and not to come near fast chargers, and not to put their bodies close to the slow chargers and its cables when using those chargers.

Manufactures and importers/distributors of chargers and EVs/PHVs will also requested to warn the users about the risk, through instruction manuals, warning labels, etc.

(Kindly provided by Banana Skins' long-term correspondent in Japan, Tom Sato, on the 29th June 2013. The Japan Ministry of Health, Labour and Welfare notice issued of 19th March 2013 can be downloaded from http://www1.mhlw.go.jp/kinkyu/iyaku_j/iyaku_j/anzenseijyouhou/302-2.pdf, but is in Japanese.)

790) Faulty fridge light caused widespread interference a with telephone network

A faulty fridge light is being blamed for a network telephone problem in Wangaratta, in northern Victoria.

The network has been plagued by interference for weeks.

Telstra technicians used hand-held antennas to track down the radio frequency noise, that was causing widespread drop-outs. They found static from a faulty light in a fridge was to blame.

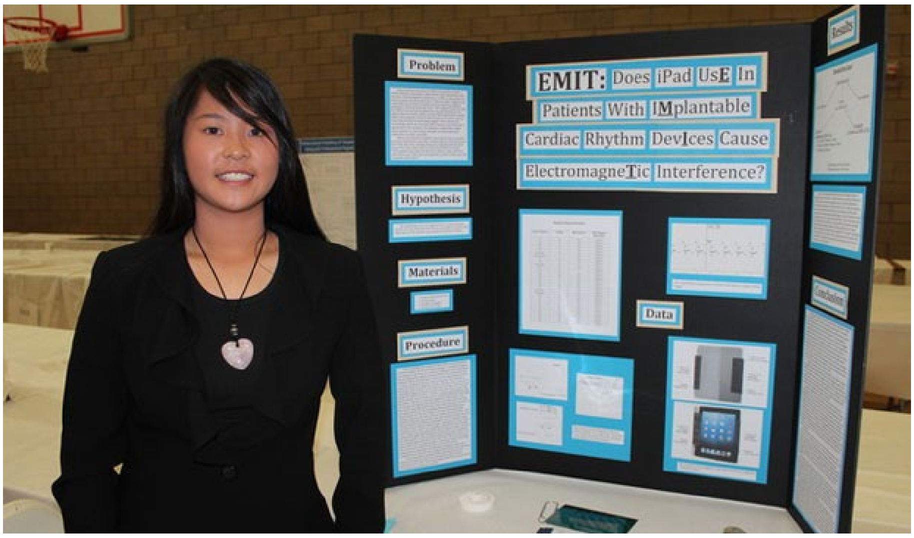
Telstra's Max Jennings says the home owner was taken aback when told his fridge was causing the interference. "I don't think he could believe that it was his fridge that was doing it," he said. "But he was very good about it and once we disabled the light, the interference source disappeared. "He can still have his cold beer."

Mr Jennings says an "enormous range" of rogue appliances can cause disruptions. "There's things called mercury vapour lamps which are often used in retail premises, domestic TV installations is a big one, even large electronic advertising signs can cause interference," he said.

(From www.abc.net.au/news/2013-06-04/fridge-light-blamed-for-phone-interference/4732534, first posted Tue Jun 4, 2013 2:23pm AEST, updated Tue Jun 4, 2013 4:02pm AEST, which was kindly provided by Banana Skins' long-term correspondent in Australia, Chris Zombolas of EMC Technology Pty Ltd, on the 6th June 2013.)

791) Study suggests Apple iPad 2 accessories could interfere with implanted cardiac devices,

A study presented at Heart Rhythm 2013 by high school freshman Gianna Chien *(pictured)* suggests that the magnets in Apple's iPad 2 tablet and accessories could interfere with cardiac devices.



Session: Poster Session II, Thursday, May 09, 2013, 9:30 AM -12:00 PM

Presentation: PO02-17 - iPad Use Can Cause Electromagnetic Interference in Patients with Implantable Cardiac Rhythm Devices

Location: Exhibit Hall

Author(s): Gianna Chien, Teri Kozik, RN, PhD, Therese Connolly, RN, BSN, Gurinder S. Grewal, MD and Walter Chien, MD. Central Valley Arrhythmia, Stockton, CA, St.Joseph Medical Center, Stockton, CA

Abstract:

Introduction: Electromagnetic interference (EMI), caused by an external signal, is a transient disruption or alteration in a cardiac rhythm device (CRD).

Multiple electronic devices have been studied to determine if they create EMI on CRDs. Magnets can create EMI and the iPad manufactured by Apple, Inc., a recently introduced tablet, has magnets imbedded in both the body and cover.

We are currently studying whether the iPad2 can cause EMI in various CRDs by either introducing noise/oversensing and/or triggering magnet mode in these devices.

Apple's iPad 2 with magnetic "Smart Cover." *(Image: Apple)*

Methods: We first tested the effect of the iPad2 on CRDs in their original packages. Trigger of magnet mode was noted by programmers supplied by device manufacturers. If magnet mode was triggered, the position of the iPad2 in reference to the device was noted. We then studied human subjects with implanted CRDs. These included subjects with defibrillators, pacemakers or loop recorders. The iPad2 effects were studied with the cellular data on and also off on the original programming settings and again on the most sensitive programming settings including unipolar sensing configuration in pacemakers. Subjects held the iPad2 at reading distance and also on top of his/her chest to mimic falling asleep while using the iPad2.

Results: iPad2 caused triggering of magnet mode on defibrillators in their package suspending anti-tachycardia therapy. A total of 19 subjects at this time have been studied including: 16 subjects with defibrillators, two subjects with pacemakers and one subject with a loop recorder. Devices tested were manufactured by St. Jude Medical and Medtronic. Two defibrillator subjects showed magnet mode trigger and one additionally had magnet mode trigger followed by initiation of the non-invasive program stimulation mode. Overall, 18.8% of the patients with defibrillators had magnet mode trigger from iPad2. No noise or oversensing was seen in packaged or implanted CRDs. No effects were seen in pacemaker or loop recorder so far.

Conclusions: iPad2 can trigger magnet mode in defibrillators and therefore suspension of anti-tachycardia therapy. Other devices with imbedded magnets are likely to cause similar interference. To date, this study suggests that interference is possible and care should be taken by individuals handling iPads with CRDs.

Disclosures: G. Chien: None. T. Kozik: I - Research Grants; 0; St. Jude Medical. T. Connolly: None. G.S. Grewal: None. W. Chien: A - Consulting Fees/Honoraria; 1; St. Jude Medical. I - Research Grants; 2; St. Jude Medical.

(The above is tken from Gianna Chien et al's study, which is available from: www.abstractsonline.com/Plan/ViewAbstract.aspx?mID=3068&sKey=4a1780d2-d99a-475f-a6e9-8228f59e7e2d&cKey=4df92828-f029-492d-8e59-88cdd1e57823&mKey=%7bCA11C8B6-ED27-4A20-953E-64F913C9A29D%7d. The Medtronic press release below is taken from a link provided by an article on the above study by Aliza Becker of Interference Technology magazine on 05/14/2013, which is available at www.interferencetechnology.com/apple-ipad-2-could-interfere-with-implanted-cardiac-devices-study-suggests.)

Press Release: Medtronic Issues Statement on iPad Interference Study

Medtronic's current internal analysis and testing shows iPad technology presents no risk of electromagnetic interference with Medtronic implantable cardiac rhythm devices when used per manufacturer's instructions. However, as a precaution, patients implanted with a pacemaker or ICD are advised to follow Apple and Medtronic labeling recommendations and maintain a distance of 6 inches (15 cm) between the iPad and implanted device.

ICD Therapy suspension and Asynchronous Pacing of IPG can be triggered by exposure to a magnet with a static magnetic field greater than 10 gauss. This is a standard functionality of most ICD and IPG (pacemaker) devices.

Medtronic proactively communicates to patients to avoid placing any magnet near the device implanted area. Since the covers of iPads often use magnets to secure them to the tablet, the presentation at Heart Rhythm 2013 is a good reminder for patients to remain vigilant on new technology and its accessories and maintain a distance of 6 inches between an iPad and implanted pacemaker or ICD.

At this time, Medtronic is not aware of any incidence of iPad interference with its implanted cardiac devices.

792) Common circuit design flaws that cause operational problems (problems fixed long ago are still showing up in designs)

Abstract: Common circuit design flaws at the board and system level cause many operational problems. Some of these flaws were understood and fixed years ago, yet still show up in designs. A few common problems of this type are discussed and examples given.

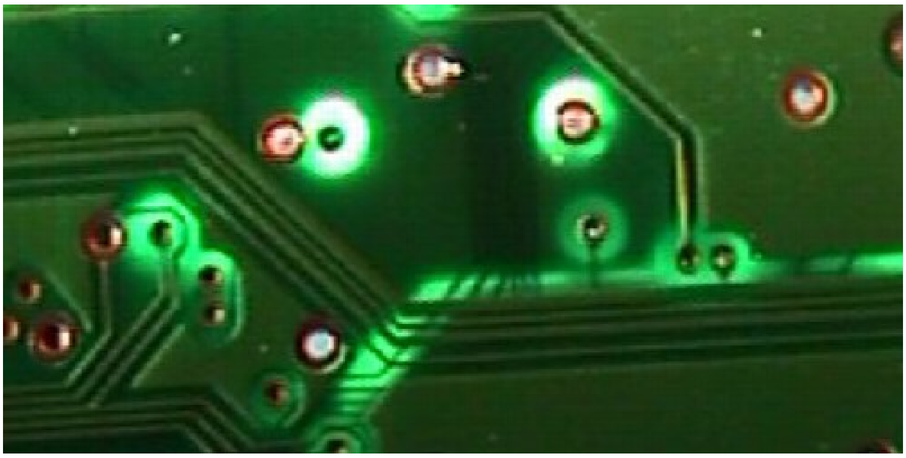


Figure 1. Circuit board with common design flaw

Discussion: In my consulting work, I see a lot of operational problems in systems that are caused by common circuit design flaws. In this Technical Tidbit, several of these flaws are discussed and examples are shown. A thread that runs through many of these examples, and my consulting work, are problems caused by attempting to separate "grounds" into different regions with "single point" connections between them. An example might be to separate a printed wiring board, PWB, ground plane into analog and digital areas.

There are a few relatively rare cases where grounds must be split apart, but when this is done a great deal of care must be taken to avoid problems. In most cases I have seen, separating grounds caused operational problems in a system. Grounds should be separated only if absolutely necessary and with concrete evidence (preferably based upon measurements) that doing so is required. Application notes in device manuals sometimes give incorrect advice on this topic.

So, let's start with my favorite problem, ground plane breaks on a PWB.

1. Ground plane breaks:

Figure 1 above shows a small section of a PWB with a light shining through the board so breaks in the power/ground planes can be easily seen.

Notice paths crossing a break in the power/ground planes at random. There are many effects of doing this covered in the linked articles at the bottom of this page. The situation is illustrated in Figure 2.

Figure 2 shows a layout diagram of a small test board, about 10 cm by 15 cm, that is used in a number of my Technical Tidbits.

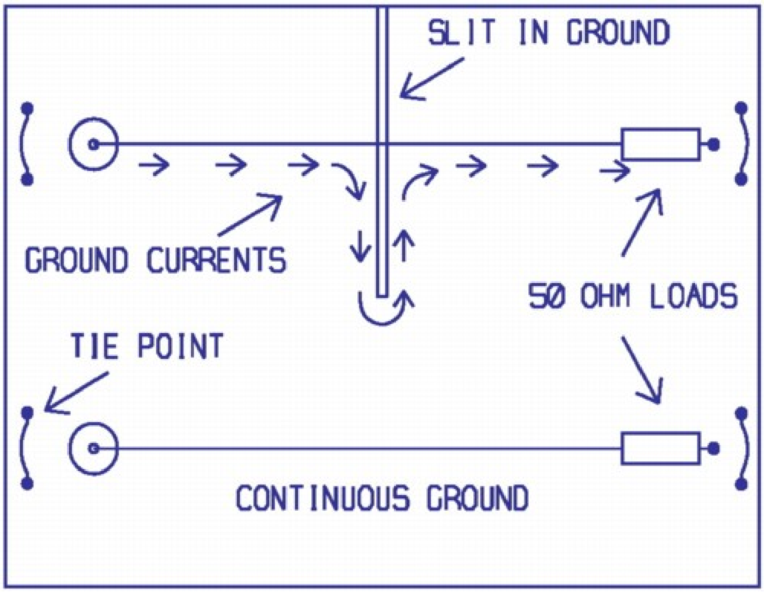


Figure 2. Drawing of Test Board With Slotted Ground

The bottom signal path is over a continuous ground plane whereas the top path crosses a 5 cm slot in the solid copper planes. The board has two planes with an identical break in each. The plane on the back side of the board is not used but is shorted to the top plane by the BNC connectors on the left end of each path.

All signals form a loop, from source to load and back again and it is the "back again" that often leads to problems. In this case, the returning current for the bottom path forms a long (the length of the signal path) but very thin loop, just a few mils in height. However, for the upper path, the returning current to the source must pass around the end of the slot in the ground plane and in doing so forms a substantial loop. The many bad effects of this loop are described in the Technical Tidbits linked at the bottom of the page and include slowed risetime, increased crosstalk to other paths, EMI emissions, and susceptibility to ESD and radiated RF fields. Figures 3 and 4 show two more examples of paths crossing plane breaks that cut all the way through the board. It is amazing to me that such features still show up in board designs today.

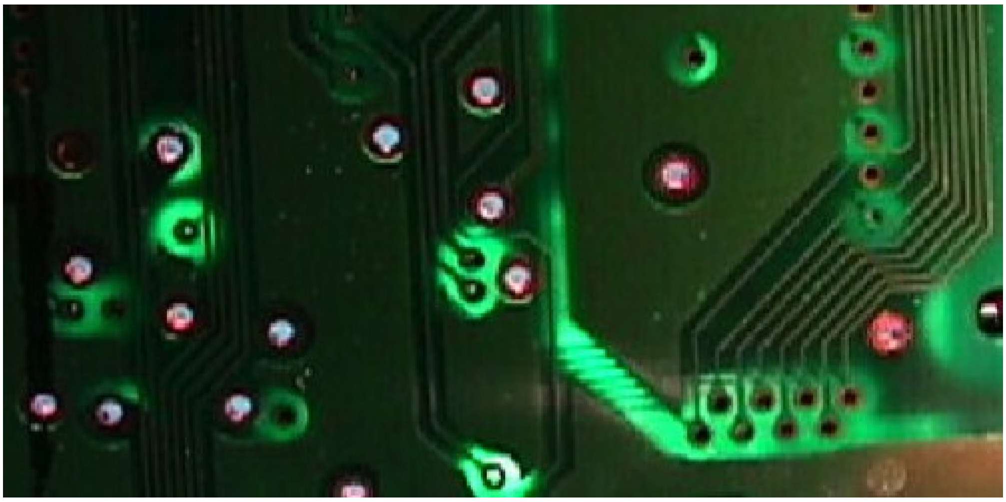


Figure 3. Another Circuit Board Example of Signals Crossing Plane Breaks

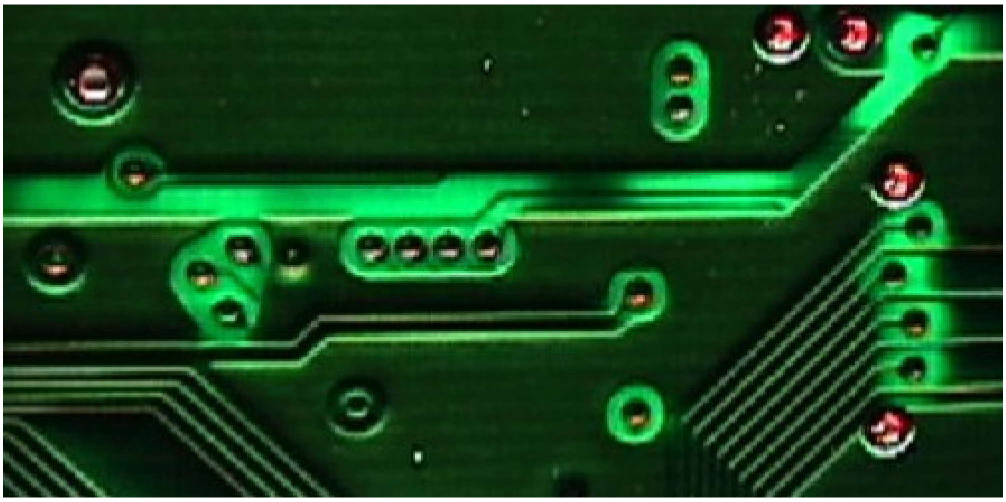


Figure 4. Third Circuit Board Example of Signals Crossing Plane Breaks

In Figure 4 there are two interesting features. The smaller one is the vertical field of vias near the lower right corner of the picture. The cutouts in the power and ground planes for these vias are large enough to overlap and form a slot in the planes. If there was enough room to get the horizontal signals in-between the vias, then there is a good chance that paths could also pass between the vias on the power and ground layers to slice up the slot into smaller pieces. Although I can't tell if this was done on this board, I doubt those paths were added.

The larger feature to note in Figure 4 is the horizontal slot between the digital and analog areas of the board (complete with a few signals paths in the break!). The designers thought the break was necessary to avoid digital noise getting into sensitive small signal analog circuits. Needless to say this board had a lot of problems including excessive emissions. When all plane breaks were filled in, the board worked perfectly (no analog problems) and emissions were reduced.

2. Single point grounding of printed wiring boards:

This feature of system design is more common than I would expect and often causes operational problems. Figure 5 shows a board from an old disk drive mounted on a copper clad board for test purposes. The results of injecting ESD at the lower left are described in my May 2002 Technical Tidbit and they are not what many engineers expect. Single point grounding of the board (the upper right connection was used in the test) resulted in a lot of current ringing at about 200 MHz due to the ESD hit. The board and copper plane formed a nice parallel plate capacitor and with the single connection point inductance formed a high Q tuned circuit at 200 MHz, not a desirable thing to do. Adding the other three connections to the copper plane raised the resonant frequency to about 500 MHz and the upper right corner connection became very quiet compared to the case where it was the only connection.

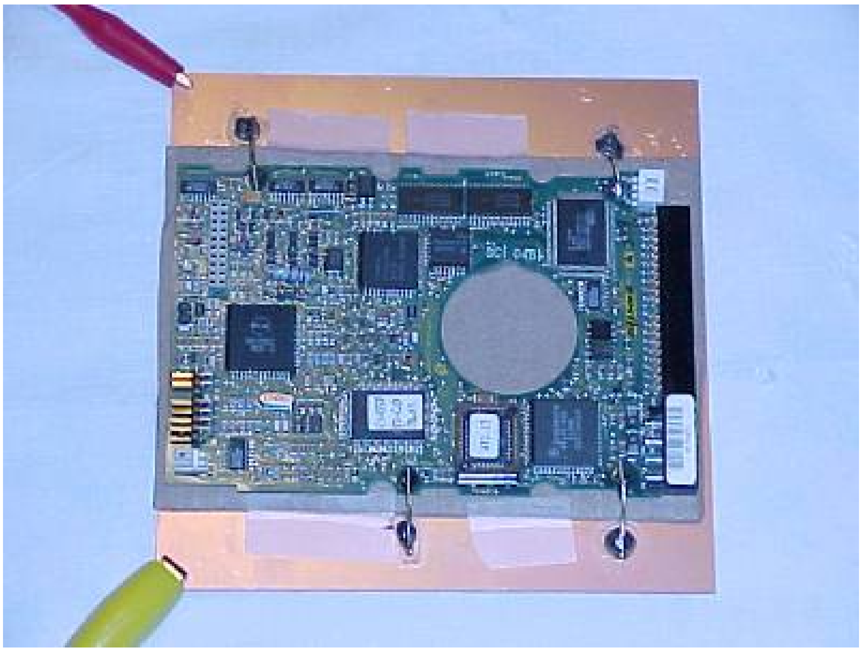


Figure 5. A Disk Drive Board Mounted Over a Copper Plane

Figure 6 shows a related example that occurs in a lot of the equipment I see. All the boards in a system are isolated from chassis except for one at a single point. This is even worst than the case shown in Figure 5. ESD to one board travels through all boards on the way to the chassis with the current path modified the the capacitance between the boards and the chassis. This case is discussed in greater detail in my March 2007 Technical Tidbit.

It is a very rare case where this system architecture is really necessary. In every case I have seen, a better alternative was available to meet system requirements.

One example would be the use of an isolated interface for those connections that really need isolation and then connect the boards securely to the chassis in many places. In rare cases, one of the chassis connections may cause a problem, and when it does, treat that case as an exception and analyze what is happening. It is a lot easier to remove an existing connection than to add a new one to a design.

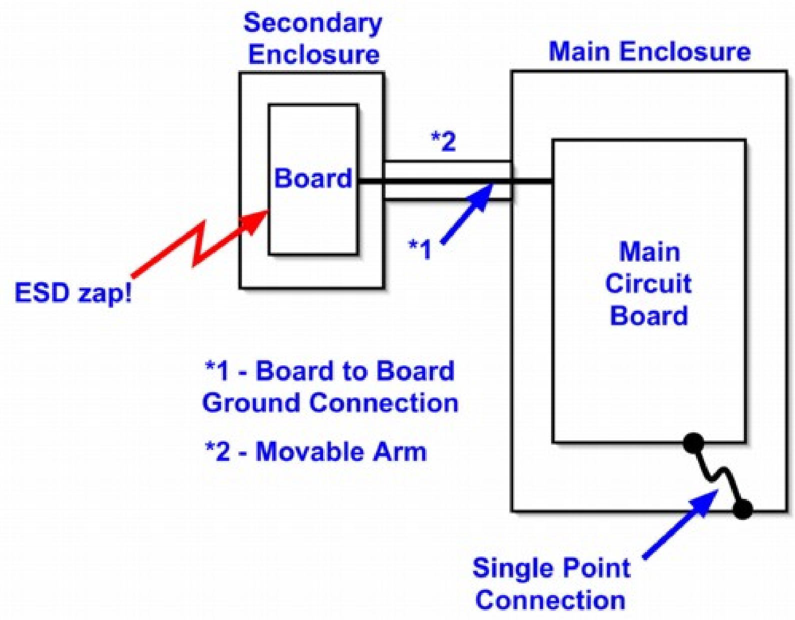


Figure 6. Circuit Boards Isolated From Chassis Ground Except at a Single Point

3. Processor reset lead routing:

This one occurs too often for comfort. I have seen processor reset leads routed all over a processor board, bad enough in itself, and then extended to a noisy I/O board as well! Recently, I worked on a case where a 10 cm reset trace on a four layer board caused the circuit to reset in response to an ESD event across the room.

The fix was to filter the reset with an RC filter near the processor. Remember, when it comes to ESD, lead lengths of one cm can be too long, for example in the RC filter example.

4. Ground bounce induced emissions problems:

Most chip packages with large chips within, such as a processor, have ground bounce on the chip relative to the board of tens of millivolts. This is enough to make all circuit traces on the board leaving the IC package RF hot to the point of causing excessive emissions.

The typical scenario is where a processor is driving an LED. Being a dc signal, the LED path is routed with no regard to high frequency effects, such as crossing ground plane breaks. However, the IC package ground bounce makes the LED signal hot enough to radiate and cause emissions failures during compliance testing.

Don't do this! Buffering or filtering the LED signal will solve the problem.

5. Off-spec use of protection components:

My final example is using components that are not specified for the application, My August 2005 Technical Tidbit describes an example of a lighting TVS protection device used for ESD protection. Small surface mount and leaded inductors have their characteristics specified at a few MHz and then we use them at hundreds of MHz.

My May 2000 Technical Tidbit shows a method of evaluating small inductors to mitigate the effects of ESD. In that article, it was shown that the best effect was obtained by placing a smaller inductor in series with a larger one.

Summary:

Some of the most frequent circuit design flaws I see in my consulting work have been described. In some cases, the problem was understood and solved years ago and yet still shows up in current circuit designs.

(This June 2007 article was copied with Doug Smith's permission from his webpage: www.emcesd.com/tt2007/tt060207.htm. Links to Technical Tidbit articles with more information on common circuit design flaws – and much else – are provided by his wonderful website http://www.emcesd.com. But beware: a quote from a visitor to this site is: "Every time I browse your

site, I never get any work done. I spend hours on it and get in trouble". Doug Smith is based in Los Gatos, California, and his email address is doug@dsmith.org.)

793) Microwave Signal May Have Caused Presidential Inauguration Video Interference

Officials have reported that interference with a microwave signal may have been the cause of audio and video problems experienced during President Obama's inauguration in mid-January.

The interference problems affected one of 12 giant video screens erected for the ceremony, and officials have thus far been unable to determine the source of the interference.

According to Tom Sharkoski, CP Communications engineering manager for the event, a channel was dedicated specifically for the inauguration feed and no equipment failure was discovered.

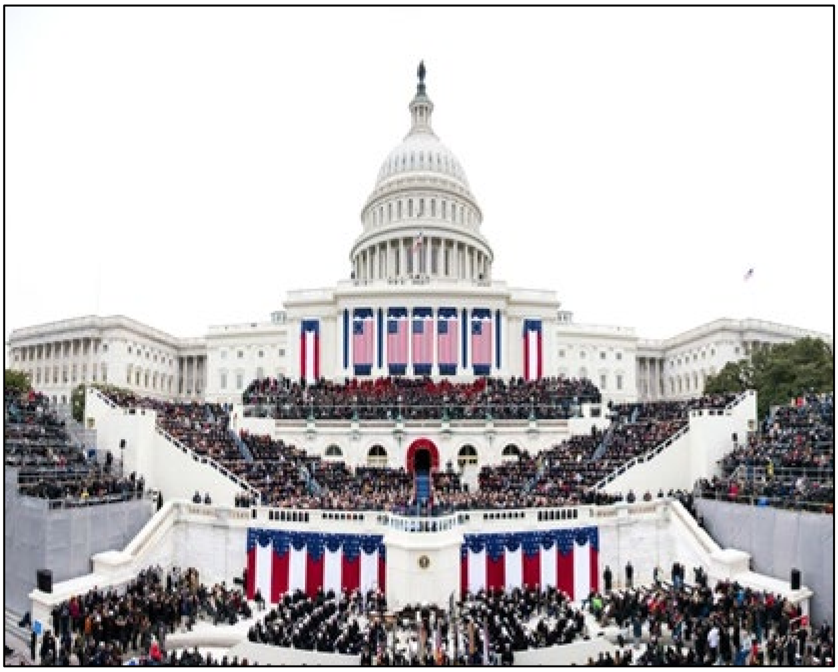


Image: Lawrence Jackson/The White House

"My heart goes out to all those people [that were unable to view the inauguration], especially those who may have traveled great distances to witness [the] event," he said.

Sharkoski added that crews located in the same area as the malfunctioning video screen were unable to communicate on their walkie-talkies while the screen was experiencing problems.

Joe Raedle/Getty Images – President Barack Obama is seen on a jumbotron during his public swearing in ceremony during his Inauguration on Jan. 21, 2013. Interference with a microwave signal may have caused one of the giant screens to fail.

(Taken from the Interference Technology article www.interferencetechnology.com/microwave-signal-may-have-caused-presidential-inauguration-video-interference 01/28/2013. For more information, visit the Washington Post for the original article by Mary Pat Flaherty published on January 26, 2013, at www.washingtonpost.com/local/what-caused-jumbotron-failure-at-inauguration-remains-unknown/2013/01/26/7f29bb80-672a-11e2-93e1-475791032daf_story.html.)

794) LTE Cellular Tower Interference onto Satellite Ground Station down links

Interference will arise as a result of the LTE and LTE Advanced cellular 4th generation build-out now occurring on a global basis. I made several assumptions and modeled the cumulative power spectral density of ALL the user hand sets around each LTE-A cell tower, and their interference to noise onto each federal earth station site in physical proximity to that federal earth station.

Since we DO know the LAT LON of each Federal Earth Station, but do NOT know where the locations of the LTE-A cell towers will be located, we assumed circles of zones for coordination and for exclusion, where cellular towers will be prohibited (hard to prohibit the hand sets, but if there is no cell tower to provide them service, then interference is not as much of a problem) and coordinated.

We found the polar federal earth stations to present a problem, since their antennas are not fixed (pointed at a single location in the sky), but move across a program track where they most likely WILL intercept power from the cumulative user hand sets. The exclusion zone for GEOSYNC was 30-35 km while the exclusion zone for polar was 300-400 km, which is as you may know is a non-starter with the cellular companies. Hence, polar sites will by definition experience problems with their data downloads on polar tracks and interference mitigation strategies must be employed, such as space (multiple antenna) diversity, filtering, etc.

The software used to formulate the user hand set PSD and CDF was Excel while the software tool used to model the interference was Visualyse (Transfinite Systems in the UK). I found the task to be a very complex issue, probably the most complex of my career, and do look forward to further work in this field.

(Kindly provided by Tim Cash on 2nd September, cash.tim@gmail.com, www.linkedin.com/in/timcash/.)

795) Some FCC Part 15 interference problems

For example, some of the telecom companies have banned or restricted WLAN devices from their switching stations because their equipment (Part 15 unintentional radiator devices) are subject to interference from WLAN devices. The problem is not the WLAN devices themselves but the fact that the industry immunity standard used in testing these devices does not use ‘real world’ transmitter emissions from a WLAN.

In First Report and Order 01-278, the commission required that radar detectors be certified (they were exempt as a receiver operating over 960 MHz). This action was to avoid a serious field complaint from VSAT (satellite terminal) operators whose services were being disrupted by radar detectors. Occasionally, the FCC has requested that a WISP (wireless Internet service provider) operating Part 12 WLAN equipment cease operation until a specific interference problem has been fixed.

(Taken from the article “A look at Part 15 interference problems” by David A case NCE, NCT, Cisco Systems Inc., in Interference Technology magazine’s EMC Directory & Design Guide 2005. www.interferencetechnology.com.)

796) Fluorescent lamps with HF ballasts emit three different types of conducted interference

Power quality is a subject that has received a lot of attention during the last 10 to 20 years, both in industry and in academia. Power quality concerns interaction between the power grid and its customers and between the power grid and equipment connected to it, reflected in voltages and currents.

Research and other developments in this area have to a great extent concentrated on relatively slow and low-frequency phenomena, with the main emphasis being on voltage dips (reductions in voltage magnitude with duration between about 50 ms and several seconds) and low-frequency harmonics (waveform distortion by frequency components up to about 2 kHz). These phenomena are reasonably well understood and several standards cover the area.

For higher-frequency phenomena, above 2 kHz, there is no such general understanding, nor is there anything close to a complete set of standards covering this area. Modern energy efficient equipment connected to the grid, like fluorescent lamps but also solar panels, often uses switching technology, with switching frequencies that can range from a couple of kHz up to several hundreds of kHz. The grid is also used for communication of e.g. meter readings, system controls etc. This so-called power-line communication is using the same frequency range.

The main frequency range of interest for this thesis has been the range from 2 to 150 kHz. There are two completely different measurement methods covering this frequency range: time-domain based and frequency-domain based. Time domain based measurements are used throughout the thesis.

This gives an opportunity to choose between different analysing tools where among others the joint time-frequency domain has shown to be a useful tool for describing waveform distortion in our frequency range of interest.

The majority of the measurements presented in this thesis have been directed towards fluorescent light powered by high frequency ballasts. This type of load has been, due to stringent harmonic limits, one of the first to use a more advanced switching technology called active power factor correction. This technique is also getting more frequently used in other small-power equipment, like computers. Installations of lights in stores etc. normally contain a large number of ballast connected together and the interaction is of importance, for example for setting emission and immunity standards.

The measurements on ballasts presented in this work have shown that distortion in the frequency rage 2-150 kHz comes in three types: narrowband distortion; wideband distortion; and recurrent oscillations. The recurrent oscillations are a new type of power quality disturbance that had not been recognized as such before.

The recurrent oscillations, which resemble commutation notches, have never been described for high-volume equipment used by non-industrial customers. In larger groups of lamps, of a different type as used in the laboratory experiment the recurrent oscillations have been shown to reach up to about 5 V in peak.

The measurements further have shown that the three types of distortion spread in a completely different way from the individual devices to the grid. This knowledge is essential for the setting of emission requirements on energy-efficient equipment.

(Extracted from the Abstract and Conclusions sections of "On High-Frequency Distortion in Low-Voltage Power Systems", PhD Thesis by Anders Larsson, Division of Energy Engineering, Department of Engineering Sciences and Mathematics, Luleå University of Technology, Printed by Universitetstryckeriet, Luleå 2011, ISSN: 1402-1544, ISBN 978-91-7439-218-0, www.ltu.se, download from http://pure.ltu.se/portal/en/publications/on-highfrequency-distortion-in-lowvoltage-power-systems(f614e609-6938-4bd0-a656-eece9cf3e2c2).html*)*

797) Garage Door Opener Interference on the Increase

There have been several instances of interference with garage door opener remotes at houses located near military installations, the FCC reports in a recent Public Notice (DA 05-4242). When the interference occurs, the controllers don't work properly. Either the range is diminished, or they stop working entirely. Hardwired manual controls are unaffected.

Legally, the garage door industry doesn't have a case, because the openers are regulated under FCC Part 15, which grants them "at sufferance" rights of operation. They can't cause interference *(I'm sure this means they are not permitted to, and not that it is impossible for them to do so – Editor)*, and they have to tolerate any interference from licensed services. Still, there's the law and there's public relations – a lot of homeowners are upset, as well as the manufacturers of the affected equipment.

Here's what's going on technically. The problem is that the receivers used in these garage door systems are usually rather simple super-regenerative units. Super-regenerative receivers can be surprisingly sensitive, considering how simple they are, but they have a major weakness: They are highly unselective, and can easily be captured by signals within 10MHz of their desired operating frequency.

This has both a strength and a weakness in this application, The strength is that the receiver and transmitting controller don't have to be precisely aligned in frequency. The weakness is that any nearby strong signal over a fairly wide frequency range – such as those from the military base radios – will interact with the receiver and may over-ride the desired controller signal, blocking communications between them.

For security reasons, the DoD (Department of Defense) doesn't want to publish the exact frequencies in use, which makes it difficult to design around. There is a technical solution – to build more selective receivers and to more precisely align their operating frequencies. The FCC may do that through a formal rulemaking in the future, affecting many types of devices operating in the range of approximately 225 to 400MHz. In the meantime, the FCC, the Department of Defense, and the National Telecommunications and Information Administration are working with device manufacturers to minimize consumer impact – possibly by developing substitutable receiver/transmitter pairs that can work at different frequencies from those in local use.

(Taken from Conformity magazine, April 2005, Newsbreaks, page 10. Conformity Magazine used to provide a wonderful archive of articles on EMC and other issues, which was maintained for some time by a 3rd Party after it folded. However, even that seems to have disappeared now, which is a great pity. Web searches now seem to only find the February and June 2006 editions in 'nxtbook' format.)

798) Cellphones still interfere with hearing aids

Over the years, hearing aids and telephones have led a sometimes troubled coexistence. Positioning the telephone earpiece near the hearing aid microphone is sometimes awkward and, due to design constraints of the hearing aid, can lead to squeals of acoustic feedback.

Several decades ago, many hearing aids began to incorporate magnetic sensing coils known as "telecoils" that responded to the stray audio frequency magnetic field from the telephone receiver, instead of to its acoustic output. This coupling mode can yield a clearer sound and avoids picking up ambient noises. Its importance led to federal regulations in the U. S. pursuant to the 1988 Hearing Aid Compatibility (HAC) Act (Public Law 100-394) that, among other things, mandated minimum requirements for telephones' magnetic fields.

Cell phones, however, were exempt from these HAC requirements. With the advent of widespread cell phone use, the exemption for wireless devices was later partially lifted [1].

As digital cell phones began to replace analog phones in the 1990's, radio frequency interference (RFI) quickly emerged as a major compatibility consideration. The primary RFI concern was then and remains audio-frequency interference related to the amplitude modulation (AM) envelope of the RF field of the wireless device (WD), which can undergo square-law detection by various semiconductor junctions within the hearing aid in both the microphone and the telecoil operating modes.

The most interfering WD transmission protocols are those that employ some form of time division multiplexing, where the carrier is repeatedly pulsed on for only a portion of the transmission time. This pulsing typically occurs at repetition rates near or within the audio frequency band. A prime example is GSM [2] modulation, which pulses with a 1/8 duty cycle at a 216.7 Hz repetition rate.

(From "Radio Frequency Immunity Testing of Hearing Aids" by Stephen D. Julstrom, Linda K. Kozma-Spytek and Brian B. Beard, in IEEE Electromagnetic Compatibility Magazine – Volume 2 – Quarter 2 – 2013, from: http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6550935.)

799) Flash-over causes problems for spacecraft

Pyrotechnic ("pyro") firing circuits typically require special attention, particularly in conservative designs. The greatest threat associated with grounding in such circuits is the phenomenon known as "pyro ground-fault currents".

Chassis currents as high as 20A may flow through the spacecraft chassis or structure during pyro firing events. This current is produced by a short-circuit formed between the positive lead of the EIED (also known as a bridge-wire actuated device) bridge wire through the ionized conductive path created when it is fired (this phenomenon occurs quite frequently, in about 25% of all firing events, and was shown to be the cause of several spacecraft anomalies and failures).

In a direct-energy-transfer system (pyrotechnic devices switched directly from the main battery bus) that is not isolated by a deliberate turn-off switch, this ground fault current could continue indefinitely. The ground fault current could also result in momentary near total power loss as well as magnetic field interference, coupling into adjacent sensitive circuits.

(Taken from Chapter 10.4.3.2 "Spacecraft Internal Grounding Considerations", in "Grounds for Grounding, A Circuit-to-System Handbook" by Elya B. Joffe and Kai-Sang Lock, IEEE/Wiley, 2010, ISBN: 978-0471-66008-8.)

800) Spinor and Tosion fields, and human health

(Every 100th Banana Skin is chosen either for its humour or its claims to stretch recognised boundaries. This is one of the latter – Editor.)

Receiving gifts is fundamentally more fraught than giving them. Consider the plight of Aaron Watson, puzzled recipient of a "Forpost 1" – claimed to provide protection from "adverse effects of…electromagnetic radiation of TV sets, PC monitors and other electronic devices". Er, thanks for the thought.

Website www.spinor.kiev.ua depicts the Forpost 1 as a stick-on disk. The unique selling proposition, distinguishing this from other stick-ons, is protection against the "torsion (information) component" of the electromagnetic field.

Of 380 web pages turned up by searching “torsion component” and “electromagnetic fields”, many talk of “bioenergy” and “new energy technologies”. We see none from an actual scientist.

The mechanism is – as always with these thingies – mysterious. US Patent 6563043 describes an “outer body, a salt solution, and a ring”. The ring “generates a first right torsion field” and may be a “topological resonator”. Its topology is interesting: it may be “cylindrical in cross-section”.

Aaron offers to send the device to the Feedback Kitchen lab to find out what is inside it. We accept – as soon as he finds a way of explaining to his mother-in-law where the gift went.

(The above is from ‘Feedback’, New Scientist, 24/31 Dec 2011, page 96, www.newscientist.com. The Editor thought he should provide Banana Skin readers with at least the starting points for investigating whether the dismissive tone of the above item was justified, see below…)

The Editor found the text and pictures below at http://spinor.kiev.ua/eng/index.php?p=8

The Forpost-1

“Device for human protection against negative impact of a Torsion Field”

The “Spinor device”

This is also a “device for human protection against negative impact of a Torsion Field”

The Forpost-1 device provides reliable and user-friendly protection from adverse effects of the torsion (information) component of electromagnetic radiation of TV sets, PC monitors and other electronic devices.

Recent studies revealed that the torsion (information) component of radiation of TV sets (PC monitors) is the most substantial factor affecting the human health.

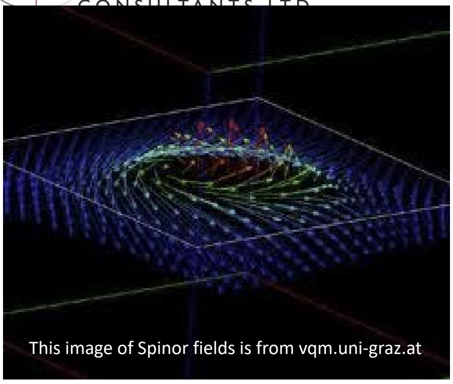
Prolonged exposure of the torsion (information) component of TV set's, PC monitor's radiation can deteriorate one’s health, cause headache, excessive fatigue, weak vision and memory, sleep disorder, reduction of the blood levels of leukocytes and lymphocytes, immunity disorders; it adversely affects the endocrine and reproductive system.

Children and pregnant women are most vulnerable to effects of torsion (information) fields.

The Forpost-1 device neutralizes harmful effects of torsion (information) component of radiation of TV sets (PC monitors, etc.) and creates a biologically safe area around a TV set (any other electronic device).

"Forpost-1" device can be used for neutralization of the negative influencing of electronics of cars, trolley buses and subway trains electronic systems.

The text on the Spinor device is identical to the text on the “Torsion device” above. Investigating the documents in the ‘Library’ at http://spinor.kiev.ua/eng/index.php?p=8 led the Editor to an article containing the following text:



This image of Spinor fields is from vqm.uni-graz.at

The article describes the research work aimed at the creation of new technologies based on the Kozyrev's ideas and realized at the International Scientific Research Institute of Cosmic Anthropology [Kaznacheev V.P., 1999].

The part of the preliminary work had been done at the Medical Institute of Novosibirsk, at the Institute of Clinic and Experimental Medicine of SB RAMS during 40 years. The scientists constructed a generator irradiating ether-dynamic stream of ether (vacuum) heterogeneity described in the works by D'atlov V.L. [1988], Akimov A.E., Shipov G.I. [1996], Dmitriev A.N. [1997], etc.

If such generator “twists” ether (vacuum) stream to the left (anticlockwise) (left torsion fields), then tissue cultures (human cells), [Kaznacheev V.P., 1999], begin actively reproduce, while the synthesis of albumen and polysaccharides goes in its ordinary way.

During the alteration of the ether (vacuum) stream rotation direction to the right (right torsion fields) the following effect is initiated: there are no mitoses, however, albumen synthesis in cells, the activity of their genomes are incredibly high in all cases.

(The above text is taken from an article by Kaznacheev V.P. published in “Physics of consciousness and life, cosmology and astrophysics”, №1,2002, Kyiv (International Scientific Research Institute of Cosmic Anthropoecology, 2, Academic. Timakov Str., Novosibirsk, Russia, 630117, www.isrica.org/. The names Akimov and Shipov also appear later in this item.)

Visiting www.isrica.org to try to find out what Anthropoecology is, the Editor found the following:

The main program objectives of the Institute are the study of living matter and intelligence on the planet Earth as cosmo- planetary phenomenon to study the effect of cosmic factors on the evolution and human health, development and testing of new methods for predicting, diagnosing, drugless prevention and correction of intractable helio-dependent diseases and accelerated aging of the human body.

In recent years, scientists of ISRICA have created an unique holographic technology which has not analogues in the world, which allows to use of living systems directly absorb cosmic energy and convert it into energy of its vital functions, enhancing protein synthesis, productivity, reproduction and resistance to many diseases.

Investigating ‘spinor fields’ and ‘torsion fields’, the Editor found that they are associated with quantum mechanics and anti-matter. The following gives a flavour, and some pretty graphics…..

The space of real spinor fields of a given mass m>0 in Minkowski space is the direct sum of two irreducibly invariant subspaces under the connected Poincaré group P. These subspaces admit unique P-invariant positive-energy complex unitarizable structures, in terms of which they are unitarily and canonically equivalent to the conventional “left electron” and “right positron” subspaces defined by the Dirac equation.

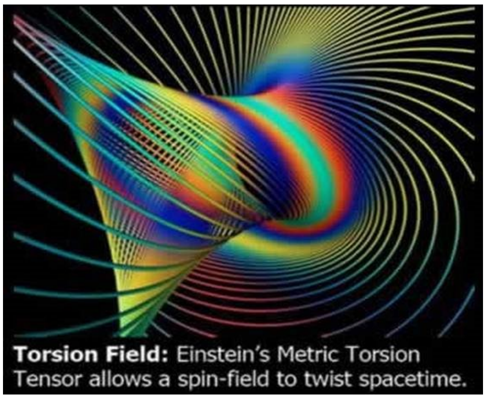
(The above is taken from: “Real Spinor Fields and the Electroweak Interaction”, Irving Segal, Journal of Functional Analysis, Volume 154, Issue 2, 20 April 1998, Pages 542–558, www.sciencedirect.com/science/article/pii/S0022123697932134.)

Torsion field can refer to:

- A torsion tensor in differential geometry.
- The field used in Einstein–Cartan theory and other alternatives to general relativity that involve torsion of spacetime
- Torsion field (pseudoscience), a field alleged to make faster-than-light communication and paranormal phenomena possible phenomena possible

(The text above is taken from http://en.wikipedia.org/wiki/Torsion_field.)

(Following up on the pseudoscience angle, the text below is taken from http://en.wikipedia.org/wiki/Torsion_field_(pseudoscience).)



This image of a Torsion field from: www.holographicarchetypes.weebly.com

A torsion field (also called axion field, spin field, spinor field, and microlepton field) is a pseudoscientific[1] theory of energy in which the quantum spin of particles can be used to cause emanations lacking mass and energy to carry information through a vacuum at one billion times the speed of light.

The theory, conceived in the Soviet Union by a group of physicists in the 1980s, is loosely based on Einstein-Cartan theory and some variant solutions of Maxwell's equations.[2]

The group, led by Anatoly Akimov and Gennady Shipov,[3] began the research as the state-sponsored Center for Nontraditional Technologies.

However, the group disbanded in 1991 when their research was exposed as a fraud and an embezzlement of government funding by Ye. B. Aleksandrov; yet, for unknown reasons Akimov and Shipov received financing for torsion field research from the Russian Ministry of Science from 1992 to 1995 and from the Russian Ministry of Defense from 1996 to 1997, and continued further secretly,[2] as a private enterprise called The International Institute for Theoretical and Applied Physics (later called UVITOR).[4]

UVITOR is operating from Bangkok, Thailand since 2005 and appears to offer medical products and services on its premise.[5] The torsion field research has secured support from a number of prominent Thai academics and the national funding agency.[6][7]

Presently championed outside of established scientific research due to its lack of scientific recognition, the theory has been used to proclaim faster-than-light travel (FTL), extra-sensory perception (ESP), homeopathy, levitation, and other paranormal phenomena, and has been used to provide a rationale for the purported functioning of miracle cures and similar products.

Detailed description

In physics, a field is an assignment of a quantity (vector, tensor, or spinor) to every point of the space containing it. The word torsion refers to any variable that describes rotation. Thus, torsion fields do exist.

For example, an electromagnetic wave with circular polarization or the stress tensor of a solid body under torsion stress can be described as torsion fields, although such usage is rare. Spinor fields, in particular fermionic fields, are existing concepts from particle physics and quantum field theory.

Beyond this established research, advocates of the scientific spin field or torsion field theories claim that spin-spin interaction — itself a well-studied quantum phenomenon — can be transmitted through space similar to electromagnetic waves, does not carry mass or energy but only information, and does so at speeds of up to 109 times the speed of light.

At the same time they claim that spin-spin interaction is carried by neutrinos — which have very little mass and high energy — that it does not interact with matter but, at the same time, can be generated and detected easily.[8]

Applications

Despite the fact that several contradictions have been identified in the basic postulates of these theories [9] (as have several statements that are considered nonsensical by mainstream science[9]), torsion field theory has been embraced by some as the scientific explanation of homeopathy, telepathy, telekinesis, levitation, clairvoyance, ESP, and other paranormal phenomena.[10]

The harnessing of torsion fields has been claimed to make everything possible from miracle cure devices (including devices that cure alcohol addiction [11]) to working perpetual motion machines, stargates, [12] UFO propulsion analogs, and weapons of mass destruction (WMDs).[13] Some such devices, in particular the miracle cure boxes, have been patented,[14] manufactured and sold.

Torsion field theories are sometimes presented as alternatives to general relativity. Examples of this include the Einstein-Cartan Theory and gauge theories of gravitation for the Poincaré and the affine groups, which seek to add torsion of space-time to the curvature-based description of gravity; and thereby predict a multitude of new physical effects.

However, the predicted effects of such alternative theories are either infinitesimal or directly contradict the experimental evidence.[15] It may be shown that space-time curvature and torsion are alternative ways of describing the gravitational field and are completely interchangeable, while attempts to account for them simultaneously produce inconsistencies.[16]

(The Editor wonders whether he would have become much wealthier (well, just wealthy would be nice!) quickly and with little effort, if he had pursued a career in pseudoscience like some of the gentlemen or ladies mentioned above. It seems that all you need to do is learn enough about some complex issues in quantum physics to bluff with them, claim they can be used to create new weapons, and get unlimited funding. Even when one government throws you out as a fraud and a charlatan, it seems that this does not prevent other governments from funding you. However, there may be a real basis for such rubbish to provide real health benefits via the placebo effect.)

801) Interference caused by gas insulated switchgear (GIS)

The quantification of emission levels from gas insulated equipment during switching events is found to be important for the EMC design of control devices operating in such harsh EM environment and hence to ensure reliable operation of the systems.

Malfunctions of the primary/secondary equipment have been reported by many authors during switching operations in a GIS due to induced/conducted voltages on control circuits.

(Taken from: "Computation of EMI Fields in a High Voltage Gas Insulated Substation during Switching Operations", by M M Rao, M J Thomas and B P Singh, presented at the IEEE International EMC Symposium, Boston, MA, USA, 18-22 August 2003, ISBN: 0-7803-7835-0/03.)

802) Guided missiles need shielding to protect from ambient EM fields

If it becomes apparent that ordnance does not comply with the environmental conditions given in the standards as it is the case with some equipment that is in use in NATO countries for several years methods of shielding have to be considered.

Examples are some types of guided missiles like MILAN which was developed more than thirty years ago and which has been shown to be sensitive to RF electromagnetic fields. For three decades the missile system has been the backbone of anti-tank defense in almost forty countries. Infantry forces will continue to rely on MILAN well beyond the year 2005.

Considering the large number of MILAN in use it is nearly impossible to try to harden the missile itself and ensure safe operation in difficult RF environment. Mostly however this is not necessary because it seems unlikely that the ordnance is exposed to strong fields during the short time of operation. During storage and especially transport there exist possibilities of shielding.

(Taken from "The safety of ordnance in high frequency and pulsed electromagnetic fields", by M Koch and W Zappe, in EMC Society of Australia Newsletter, Sep 2004 Issue Number 27, page 11, www.engineersaustralia.org.au/emcsa#news.)

803) PWM motor drives interfere with digital multimeters

However, a standard true-rms multimeter cannot reliably read the output side of a PWM (pulse width modulated) drive, because the VSD applies a non-sinusoidal PWM voltage to the motor. A true-rms DMM reads the heating effect of the non-sinusoidal voltage applied to the motor, while the output voltage reading from the motor controller only displays the rms value of the fundamental component (typically 30-60 Hz).

The causes of this discrepancy are bandwidth and shielding. Many of today's true-rms digital multimeters have bandwidths up to 20kHz or more, causing them to respond not only to the fundamental component – which is what the motor responds to – but to all of the high-frequency components generated by the VSD.

And if the DMM is not shielded against high-frequency noise, the drive's high noise levels can make the measurement discrepancies worse. The combination of the bandwidth and shielding issues means that many true-rms meters display reading up to 20-30% higher than indicated by the drive controller.

(From "Driving for test accuracy" by Fluke, in the "Troubleshooting" section of Drives & Controls magazine, October 2005, www.drivesncontrols.com.)

804) Vehicle tracking system GPS jammer interferes with Newark Airport: $42,500 fine

3. On August 3, 2012, the Enforcement Bureau (Bureau) received a complaint from the Federal Aviation Administration (FAA) reporting that the Port Authority of New York and New Jersey (Port Authority) had been experiencing interference during pre-deployment testing of a ground-based augmentation system (GBAS) at Newark Liberty International Airport (Newark Airport).7

The GBAS provides enhanced navigation signals to aircraft in the vicinity of an airport for precision approach, departure procedures, and terminal area operations.

4. An agent from the Bureau's New York Office investigated the matter at Newark Airport on August 4, 2012. While driving toward the Guard Post India Gate at the Newark Airport, the agent determined, using direction finding techniques, that a red Ford F-150 pickup truck with New Jersey license plates (Red Ford) was emanating radio signals within the restricted 1559 to 1610 MHz band allocated to the Radionavigation-Satellite service and used by the GPS satellite navigation system.

The signals emanating from the vehicle were blocking the reception of GPS signals by the GPS receivers used in the GBAS. Port Authority police and security personnel, working closely with the FCC agent, stopped the Red Ford at the gate. Using handheld direction finding equipment, the FCC agent confirmed that strong wide-band emissions in the restricted 1559 to 1610 MHz band were emanating from the Red Ford.

The FCC agent interviewed the driver, who identified himself as Gary Bojczak and admitted that he owned and operated the radio transmitting device that was jamming GPS transmissions. Mr. Bojczak claimed that he installed and operated the jamming device in his company-supplied vehicle to block the GPS-based vehicle tracking system that his employer installed in the vehicle.

Mr. Bojczak voluntarily surrendered the jammer to the FCC agent. After the jammer was removed from the Red Ford and turned off, the agent confirmed that the unauthorized signals had ceased.

12. In light of the disruption caused to sensitive aeronautical navigation equipment designed to protect public safety, we apply a 50 percent upward adjustment to the base forfeiture amount for interference, resulting in a proposed forfeiture of $42,500.26

(Extracts from FCC 13-106, 2nd August 2013, kindly sent in by Peter Warburg, a Principal Engineer with General Dynamics Broadband, http://transition.fcc.gov/Daily_Releases/Daily_Business/2013/db0802/FCC-13-106A1.pdf.)

805) Conducted Emissions in Distribution Systems (1 kHz-1 MHz)

With the advancements in power electronics and power converters more and more loads on distribution systems are connected via power converters. This is particularly true for energy efficient lighting and variable frequency drives. Renewable generation is another growth area in distribution systems, which also tends to be connected to the grid via power converters. The proportion of non-linear devices connected to distribution systems is therefore rapidly increasing and may already be over 60% [1].

At the same time, there is an increase in communications and control equipment closely associated with power systems for the smart grid and micro grid concepts. There is therefore a concern that significant conducted emissions from these nonlinear devices on the power system may lead to EMC problems.

Already problems due to increased transformer losses have been reported and other evidence of equipment damage [2, 3]. Assessing the level of electromagnetic interference due to conducted emissions on power systems is very problematical due to the large variability in the operation and connection of generators and loads. The cabling and overhead line characteristic impedance can also vary from 30-300 ohms. This is quite different from other environments where the connected equipment does not change and the propagation impedance is constant (e.g. 377 ohms for radiation or 50 ohms communications transmission lines). There is thus a significant range of uncertainties associated with the assessment of conducted emissions both in measurement and the assessment of the cumulative effect of the devices. To date theoretical prediction of cumulative effects of the emissions have not been fully successful.

Currently suitable standards are under development, but this article shows that there are many uncertainties associated with these conducted emissions. The first is that modern power converters connected to motors or generators have a large range of operating conditions which needs to be considered. Second, the power networks themselves also have a large range of properties both dynamic and static characteristics and a statistical approach to their impact needs to be developed.

Third, the emission from modern converters varies with time due to the action of active power factor correction and methods of measuring this such as STFT needs to be standardised. Finally, to date no satisfactory method for assessing the complete system performance without measuring or modeling the complete system has yet been developed.

[1] J. C. Das, "Power System Analysis: Short-Circuit Load Flow and Harmonics", CRC Press, 2011.

[2] R. B. Timens, F. J. K. Buesink, V. 'Cuk, J. F. G. Cobben, W. L. Kling and F. B. J. Leferink., 'Harmonic Distortion in a New Building due to a Multitude of Electronic Equipment', 2011 IEEE International Symposium on EMC, Long Beach, CA, USA.

[3] T. Sels, J. Declercq, J. Lopez-Roldan, D. van Dommelen, and R. Belmans, "The impact of repetitive combined voltages with low and high fundamental frequencies on the ageing of cast resin," in Proc. Int. Conf. on Electricity Distribution (CIRED), Turin, June 2005.

(Extracted from: Conducted Emissions in Distribution Systems (1 kHz-1 MHz), by Prof. David Thomas, Vice-Chair IEEE EMC Society TC 7 – Low Frequency EMC, in the IEEE EMC Society Magazine Volume 2 Quarter 2, 2013, pp101-104, from: http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=06550941.)

806) An EMC crisis during a teleconference at Goldman Sachs

The story goes that an all-important board meeting had trouble getting input on year-end figures due to noise on a teleconference connection.

It turned out that many of the electronic devices carried by board members were of the continuous-polling type, and the constantly emitted RF signals were being converted to audio noise inside the teleconference equipment.

A board member was assigned to investigate the circumstances, which resulted in the initiation and development of an ANSI standard for the RF immunity of office equipment.

(An extract from: "An update on the C63 standards" by Thomas Mullineaux, Evaluation Engineering, Dec 2005, www.evaluationengineering.com/articles/200512/an-update-on-the-c63-standards.php)

807) Medical immunity test standard initiated after wheelchair suffered EMI

The ANSI C63.18 standard describes a recommended method of testing medical equipment for immunity against common emitters such as cellphones and walkie-talkies.

The standard actually was initiated after an electric wheelchair took off on its own when a police officer in a nearby cruiser keyed the radio set.

(Another extract from: "An update on the C63 standards" by Thomas Mullineaux, Evaluation Engineering, Dec 2005, www.evaluationengineering.com/articles/200512/an-update-on-the-c63-standards.php)

808) Lightning strike bounces along road, causes many TVs to fail

No doubt like many readers, I have accumulated, over the years, a number of cordless power tools, and their associated chargers.

Earlier this year, I was rather surprised to find that two chargers had failed simultaneously. In one, the primary winding of the transformer had gone open circuit, in the other, the rectifier had failed, and it was producing AC not DC.

I subsequently found that the battery that was in the charger with the failed primary was refusing to accept charge from a new, healthy charger. I made these discoveries shortly after an intense lightning storm, which, given that we are supplied off an underground network, should not have impacted on the supplied voltage. Less than a week later, a cordless phone failed inexplicably. At the time of the storm, it was resting in its mains-powered charger.

Many years ago, in a previous house, a lightning strike was actually seen bouncing down the road, following which a television mains transformer failed, as did those belonging to a number of neighbours. This was easily established, as one of them was a television repair man, who got the repair work from the rest of us.

Such simultaneous failures seem beyond the realm of coincidence, and the availability of multiway sockets with anti-surge protection for (typically) computers and peripherals seems to suggest that such events are not uncommon. I use one for the computer, and have, as yet, encountered no similar problems there.

Is there more anecdotal evidence of such events?

Does the apparent excursion of supply voltage outside statutory limits come within the definition of spikes, and hence beyond the responsibility of the DNO *(i.e. Distribution Network Operator – Editor)*?

More specifically, is there any readily available device which will protect an entire domestic installation, rather than individual appliances or groups of appliances?

(From: "When lightning strikes" by Chris Tigwell, BSc CEng MIET, IET Power Engineer, Volume 20, Issue 5, October 2006, page 13, DOI: 10.1049/pe:20060512, Print ISSN 1479-8344, Online ISSN 1741-0517, at: http://digital-library.theiet.org/content/journals/10.1049/pe_20060512?crawler=true)

809) Turning-off IPhone was critical, say pilots citing interference

The regional airliner was climbing past 9,000 feet when its compasses went haywire, leading pilots several miles off course until a flight attendant persuaded a passenger in row 9 to switch off an Apple Inc. (AAPL) iPhone.

"The timing of the cellphone being turned off coincided with the moment where our heading problem was solved," the unidentified co-pilot told NASA's Aviation Safety Reporting System about the 2011 incident. The plane landed safely.

Public figures from U.S. Senator Claire McCaskill to actor Alec Baldwin have bristled at what they say are excessive rules restricting use of tablets, smartphones, laptops and other devices during flights.

More than a decade of pilot reports and scientific studies tell a different story. Government and airline reporting systems have logged dozens of cases in which passenger electronics were suspected of interfering with navigation, radios and other aviation equipment.

The FAA in January appointed an advisory committee from the airline and technology industries to recommend whether or how to broaden electronics use in planes. The agency will consider the committee's recommendations, which are expected in July, it said in a statement.

Laboratory tests have shown some devices broadcast radio waves powerful enough to interfere with airline equipment, according to NASA, aircraft manufacturer Boeing Co. (BA) and the U.K.'s Civil Aviation Authority.

Airlines Split

Even Delta Air Lines Inc. (DAL), which argued for relaxed rules, told the U.S. Federal Aviation Administration its pilots and mechanics reported 27 suspected incidents of passenger electronics causing aircraft malfunctions from 2010 to 2012. Atlanta-based Delta said it couldn't verify there was interference in any of those cases.

The airline industry has been divided. Delta said in its filing that it welcomes more electronics use because that's what its passengers wanted. United Continental Holdings Inc. said it preferred no changes because they'd be difficult for flight attendants to enforce.

CTIA-The Wireless Association, a Washington trade group representing mobile companies, and Amazon.com Inc. (AMZN), the Seattle online retailer that sells the Kindle e-reader, urged the U.S. FAA last year to allow wider use of devices. Personal electronics don't cause interference, CTIA said in a blog post last year.

10,000 Feet

Passengers' use of technology and wireless services "is growing by leaps and bounds" and should be expanded as long as it is safe, the Consumer Electronics Association, an Arlington, Virginia-based trade group, said in its filing to the FAA last year.

Federal Communications Commission Chairman Julius Genachowski agreed in a Dec. 6 letter to the FAA.

Broader use of on-board electronics would help providers of approved aircraft Wi-Fi services by letting passengers use them longer. Gogo Inc. (GOGO), based in Itasca, Illinois, says it has 82 percent of that market in North America, and Qualcomm Inc. (QCOM) on May 9 won permission from the FCC to proceed with a planned air-to-ground broadband service for Wi-Fi equipped planes.

The FAA prohibits use of electronics while a plane is below 10,000 feet, with the exception of portable recording devices, hearing aids, heart pacemakers and electric shavers.

Once a flight gets above that altitude, devices can be used in "airplane mode," which blocks their ability to broadcast radio signals, according to the FAA. There's an exception for devices that aircraft manufacturers or an airline demonstrates are safe, such as laptops that connect to approved Wi-Fi networks.

Inflight Wi-Fi

The potential risks from personal electronic devices are increasing as the U.S. aviation system transitions to satellite-based navigation, according to the FAA. In order to improve efficiency, planes will fly closer together using GPS technology.

As a result, interference from electronics “cannot be tolerated,” the agency said last year.

While sticking with its prohibitions on use during some phases of flight, the FAA starting in 2010 issued guidelines allowing broader use of personal electronics.

Following techniques suggested by RTCA Inc., a Washington-based non-profit that advises the FAA on technology, airlines have been able to install Wi-Fi networks allowing passengers to browse the Web in flight.

No Tolerance

Four in 10 airline passengers surveyed in December by groups including the CEA said they want to be able to use electronic devices in all phases of flight. Thirty percent of passengers in that same study said they’d accidentally left on a device during a flight.

McCaskill, a Missouri Democrat, has called for lifting restrictions on non-phone devices such as the Kindle if passengers keep them in airplane mode, Drew Pusateri, her spokesman, said in an interview. The existing rules are “ridiculous,” she said. “I was aware from the research that’s been done that there has never been an incident of a plane having problems because of someone having a device on in the cabin,”.

The dangers from radio waves interfering with electronic equipment has been known for decades.

A fire aboard the aircraft carrier USS Forrestal in 1967 killed 134 people, when a rocket on a fighter jet accidentally fired after a radar beam triggered an electronic malfunction, according to a 1995 NASA review.

GPS Useless

Restrictions on U.S. commercial aircraft began in 1966 after research found some portable radios interfered with navigation equipment, according to the FAA’s request last year for comments on whether it should change existing rules.

In one 2004 test, a now-discontinued Samsung Electronics Co. wireless phone model’s signal was powerful enough to blot out global-positioning satellites, according to NASA. The device, which met all government standards, was tested because a corporate flight department had discovered the phone rendered a plane’s three GPS receivers useless, NASA’s researchers reported.

While incidents haven’t led to any commercial accidents and are difficult to recreate afterward, they continue to pile up. A log kept by the Montreal-based International Air Transport Association airline trade group recorded 75 cases of suspected interference from 2003 to 2009, Perry Flint, a spokesman for the group, said in an interview.

Ghost Theories

Peter Bernard Ladkin, a professor of computer networks at the University of Bielefeld in Germany, compiled similar accounts from pilots in Europe, he said in an interview.

“These are serious, conscientious pilots,” Ladkin said. “They know what they’re doing. They don’t subscribe to theories about ghosts or something.”

Damaged devices have transmitted on frequencies they weren’t designed for, according to David Carson, an associate technical fellow at Boeing who has participated in industry evaluations of electronics.

If those radio waves reach an antenna used for navigation, communication or some other purpose, it may distort the signal it’s supposed to receive.

Inflight Wi-Fi systems are safe in part because devices connect to them at low power levels, according to Carson, who was co-chairman of an RTCA panel that produced testing standards.

Devices searching for a faraway connection, such as a mobile phone trying to connect to a ground network in flight, send out more powerful radio waves, he said.

Pilots’ IPads

Airlines such as Delta and Alaska Air Group Inc. (ALK) have used the FAA guidelines to allow their pilots to carry Apple iPads to replace paper charts and manuals. McCaskill and others have used that as an example of why passengers should be allowed to use tablet computers during landing and takeoff.

One difference is that airlines don't purchase tablet models that use connections through wireless phone networks. Similar devices used by passengers haven't been tested for safety in the passenger compartment, Carson said. Plus, there's no guarantee passengers will put the devices into airplane mode or the devices haven't been damaged, he said.

"Something a passenger brings in, you don't know if it fell in a mud puddle or they put a bigger battery in," he said.

The RTCA group recommended against allowing passengers to use devices during taxi, landing and takeoff, Carson said.

The Association of Flight Attendants, the U.S.'s largest union for those workers, told the FAA last year that electronic devices should be stowed during those critical phases of flight, just as bags and purses must be.

Any decision should be based on science, not on politics or passengers' desires to stay connected, John Cox, a former airline pilot who is chief executive officer of the Washington-based consulting firm, Safety Operating Systems, said in an interview.

"The question is: Do we want to do aviation safety based on lack of testing and certification standards?" Cox said.

To contact the reporter on this story: Alan Levin in Washington at alevin24@bloomberg.net

To contact the editor responsible for this story: Bernard Kohn at bkohn2@bloomberg.net

(From: "Turning Off IPhone Critical to Pilots Citing Interference", Bloomberg, 13/08/2013, at: www.bloomberg.com/news/print/2013-05-15/turning-off-iphone-critical-to-pilots-citing-interference.html)

810) ESD bites the Blackberry

The Wall Street Journal recently reported that some models of the popular Blackberry wireless e-mail device have experienced ESD problems this winter. The paper reported that some users found that their units would shut off in cold weather, requiring a time consuming restart which interrupts the desirable "always on" operation and results in delayed e-mails.

Apparently, the problem isn't terribly severe as these things go. Research in Motion, the Blackberry's manufacturer, says it receives only a few complaints a week, which is a tiny fraction of its subscribers (RIM recently reported that the number of its subscribers broke the one-million barrier). Moreover, while either a reset or a trip to the unit's cradle is necessary to fix the problem, only time is lost – not valuable data, and the device is undamaged. Many of us who have worked with ESD problems have experienced a lot worse!

It is an unfortunate fact that in the winter environment very high electrostatic potentials can be generated *(when below-zero temperatures lower the humidity of the air to less than 25% - Editor)*. These voltages may substantially exceed the levels commonly called out in ESD standards. Careful design and testing to these standards provides some measure of protection, but, alas, there is no absolute guarantee in the real world.

(From: "ESD Bites the Blackberry", Conformity, April 2004. Unfortunately, the wonderful archive of Conformity magazine articles that a kind person kept on the web for some years after the demise of that magazine, is no longer available. However, there are various references to possible ESD problems with Blackberry phones on the 'crackberry' forum – try: http://forums.crackberry.com/blackberry-torch-9800-f209/strange-battery-activity-electric-shocks-807755/ and http://forums.crackberry.com/general-blackberry-discussion-f2/esd-bad-your-blackberry-418803/.)

811) Space dust suspected of causing EM pulses that disable satellites

A Stanford researcher claims to have discovered the reasoning behind why some satellites inexplicably fail without extensive or visible damage.

Although impacts with large space objects in space remain a potential cause, according to aeronautics and astronautics assistant professor Sigrid Close, the most likely cause of satellite failure is impacts from fast-moving micro-meteoroids known as "space dust" that turn into "a quasi-neutral gas of ions and electrons known as plasma" when they collide with other objects in space. Close theorized that this "plasma" has the potential to create an electromagnetic pulse that can damage and even completely disable any satellite it collides with.

"Spacecraft transmit a radio signal, so they can receive one that might potentially disable them," Close said. "So, our question was: Do these plasmas emit radio signals, and if so, at what frequencies and with what power?"

During experiments at the Max Planck Institute for Nuclear Physics in Germany, researchers fired dust particles at speeds of 60 km/s towards targets representing satellites. The experiments confirmed that "when these particles hit, they create a plasma or quasi-neutral gas of ions and electrons, and that plasma can then emit in the radio frequency range," Close said.

According to Close, the next step will be to prove that the effects occur similarly in space as they do in the laboratory, using an experiment being designed in cooperation with James Smith and Henry Garrett of NASA's Jet Propulsion Laboratory.

Close believes that the discovery could help explain the loss of older satellites, such as the disappearance of the European Space Agency's Olympus communication satellite in 1993, and could help to create design modifications that may better protect satellites from electronic systems failure in the future.

(From: "EMP Blasts Emitted by "Space Dust" Determined as Cause for Satellite Failure" by Aliza Becker, Interference Technology, 03/05/2013, www.interferencetechnology.com/emp-blasts-emitted-by-space-dust-determined-as-cause-for-satellite-failure. For more information, visit Stanford University: http://news.stanford.edu/pr/2013/pr-space-dust-threat-022613.html.)

812) An EMI-related safety accident in a gypsum mine

A gypsum mine bought some Intrinsically Safe [redacted] *(redacted – Editor)* handheld radios on 80MHz FM (principally because of their IP rating and rugged cases).

They accessed the mine via a surface drift which had a large cable winch installed at the top to assist the ascent and descent of Landrover personnel carriers and wheeled excavators up the 30deg incline. The winch was operated by pushbuttons on a cable pendant, the winch supervisor held the pendant whilst attaching or detaching the winch cable to the vehicle and there had been some incidents where the operator was nearly pulled into the winch drum.

So one handheld radio was fitted into a box and controlled the winch via tone filters, detectors and relays, the winch supervisor wore another radio fitted with up/down and stop/go buttons coupled to tone generators, and a portable unit was thrown into each vehicle as it coupled on to the rope.

The idea was that the winch operator and vehicle units had both to be generating a 'go' tone before the winch would move. All designed by an 'electronics expert' on the company staff.

The problem was that the tone detectors were simple band-pass audio filters followed by a diode detector and also that the nearby RAF station used 80MHz AM for their airfield security.

Then came a slight change in local BBC Radio 2 frequency, intermodulation between the RAF and Radio 2 frequencies landed on top of the winch receiver frequency, this is an FM radio so it would output lots of white noise in this situation, noise that would pass straight through the tone filters and cause the relays to operate.

To be really unsafe it required the winch operator to be cleaning the winch cable on the main drum at the same time as the RAF transmitted, but it did eventually happen – with awful consequences.

Of course it was the fault of the [redacted]*(redacted – Editor)* radios and the HSE Inspector took a lot of convincing otherwise, but eventually the system at the gypsum mine was issued with a prohibition notice………but the mining company did not think to apply it to all their installations, until it happened again.

(Kindly provided by Peter Burne, on the 13th September 2013.)

813) EMI Named as Cause in Ferry Crash Lawsuit

A 2011 ferry crash could be the result of inadequate electromagnetic shielding.

BC Ferries is suing a German manufacturer of ship control systems in connection with a 2011 incident in which a ferry rammed a dock in Nanaimo, British Columbia, Canada

The British Columbian ferry operator is seeking [1] at least $4 million in damages from SAM Electronics GmbH for the Dec. 20, 2011 crash at Duke Point, which injured seven passengers and nine crew members and required several months' worth of repairs.

In its court document, BC Ferries alleges that an isolating amplifier in the bow propulsion pitch control system, which controls the angle of the propeller blades, was not properly shielded against electromagnetic interference, resulting in the crash. In addition, the controls for the equipment were difficult to decipher and no audible alarm to warn the crew of danger was available.

An investigative report [2] released by Canada's Transportation Safety Board following the accident also said that the equipment malfunctioned, but added that the problem in the propulsion controls was missed because crew members did not follow proper procedures for testing the equipment before docking.

The ferry struck the Duke Point dock at a speed of approximately 5.6 knots, resulting in damage to both the vessel and the dock. The ferry was reportedly out of service for 23 days, while the dock was closed for repairs for three months.

BC Ferries has since implemented a variety of new systems and operating procedures designed to prevent similar accidents and better prepare the crew in the event of a problem.

[1] https://s3.amazonaws.com/s3.documentcloud.org/documents/997138/civil-claim-b-c-ferries-vs-sam-electronics-gmbh.pdf, also https://www.documentcloud.org/documents/997138-civil-claim-b-c-ferries-vs-sam-electronics-gmbh.html

[2] http://www.tsb.gc.ca/eng/rapports-reports/marine/2011/M11W0211/m11w0211.pdf

(From a report of the same name by Aliza Becker on 12/23/2013 in Interference Technology's eNews magazine, www.interferencetechnology.com/ferry-crash-emi.)

814) EMI filters pass individual equipment tests, but resonate when in a system

Recently, a power system manufacturer and a customer (a major aircraft prime contractor to the military) collaborated in resolving an interaction problem in a complex system. A custom airborne PDU incorporated an EMI filter designed to meet the aircraft's EMI attenuation specification with adequate margin. The filter passed its lab test easily. The individual aircraft equipment items met their individual EMC requirements.

The combined aircraft equipment system showed some excessive EMI noise that should easily have been suppressed to within specification when buffered by the PDU filter. When the two systems were mated, the equipment was expected to meet the EMI specifications readily. Surprisingly, the EMI increased drastically and at a low frequency of about 45kHz (and at higher multiples of that frequency).

Individual systems were, on by one, cycled on and off to determine which was affecting the pattern. When the aircraft computer was shut down, the EMI disappeared. The aircraft computer had its own EMI filter to reduce the noise from its SMPS.

The investigation disclosed that the aircraft computer EMI filter was resonating with the power distribution unit's EMI filter at the problem frequency. The filter engineer was able to redesign the PDU EMI filter in the field and to move its resonance to a point where it would not resonate with the aircraft's computer filter.

These types of problems can occur whenever there are significant modifications to a complex system, and they require due diligence from the design team.

(From an article entitled "EMI considerations for Power Distribution Units" by James F McNulty, of Marway Power Systems, in Interference Technology's 2003 Annual Guide, www.interferencetechnology.com)

815) Low voltage LED string triggers shop's burglar alarm

There is a new comment on the post "The energy-saving LED bulb that switched off the radio". http://conversation.which.co.uk/energy-home/led-bulb-radio-interference-dab-test/

Author: Dave D   Comment:

Interesting that this congo should resurface again: yesterday I went to my local electrical retailers for a few oddments and noticed that he had his managed alarm system engineer in, tinkering with the controls.

As I always have a chat with the proprietor anyway we got talking and after a while the alarm engineer came and asked to speak to Phil. The conversation as along the lines of:

"When did you first get these false alarms?" ... "about 3 weeks ago, about midnight" ....

"Does it happen every day?" ... "yes" ... "about the same time?" .... "yes" ......

"And always the same zone?" .... "yes" ..... "the shop windows?" .... "yes"....

The engineer went away for a while and was poking around in the shop window and then came back to ask:

"It looks like you've recently had the lights changed over the window?" .... yes, that was about 3 or 4 weeks ago".....''what sort did you have before?" .... "Fluorescent tubes"......

The engineer went away again, and then came back.

"I think I've solved it, do your window lights automatically switch off late at night ?" ... "Yes, about 11:30ish"

"I think it's these new spotlights you've had in, the driver unit is near to the alarm cables and I think it's causing interference when it switches on and off"

"Why doesn't it set the alarm off when they switch on then?" ....

"What time do they come on?" .... "about 9:00 in the morning" ...

"And are you usually here before they come on?" ... "oh yes, about half an hour before" ...

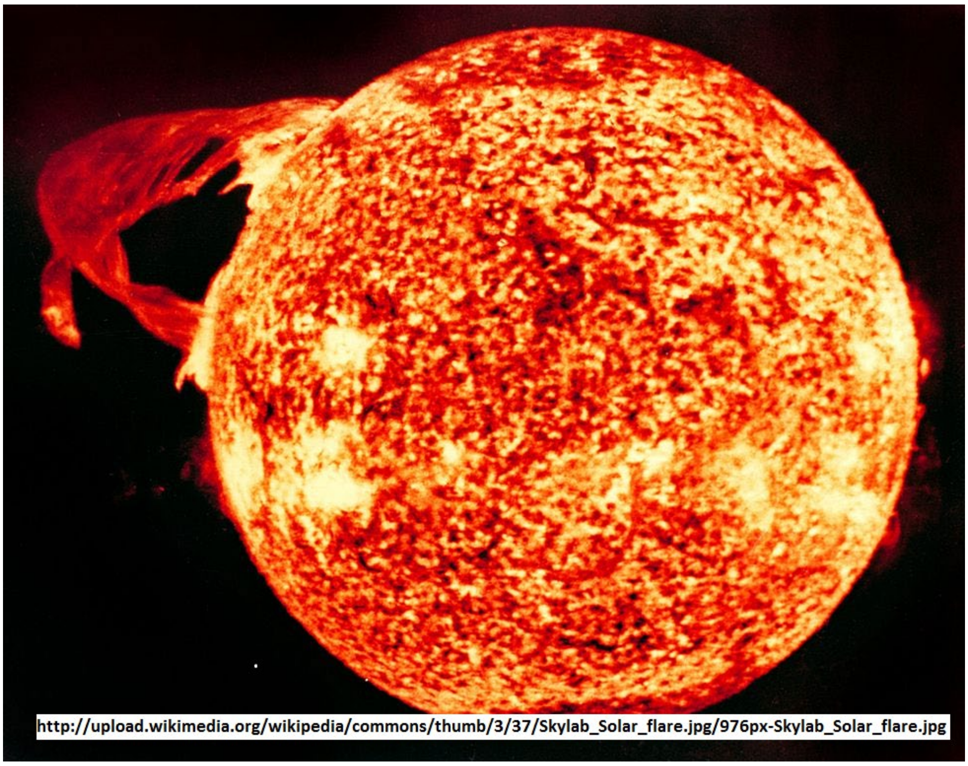
"So the alarm is not set when the lights come on ?" ..... "ah, I see what you are saying!"

Engineer and shopkeeper then locked shop door briefly, switched off window lights, set alarm and switched on window lights ..... sirens blaring, lights flashing ......

So it seems that the LED driver unit for the little low voltage LED track of lights over the window causes EMF (or EMI) triggering burglar alarms too.

(Kindly supplied by Richard Marshall, of Richard Marshall Ltd., www.design-emc.co.uk, on 5 November 2013. Which? magazine says "see all comments on this post here: http://conversation.which.co.uk/energy" but this is a list of hundreds of posts and I found it easier to go straight to http://conversation.which.co.uk/energy-home/led-bulb-radio-interference-dab-test – Editor.)

816) Satellites Need Better Shielding from Space Weather



Scientists are investigating the effects of extreme space weather on geostationary satellites with the intention of better preventing electronics failure.

In a new study published in Space Weather, researchers from the Massachusetts Institute of Technology (MIT) say that solar flares, geomagnetic storms and other forms of electromagnetic radiation may be to blame for up to 26 failures in eight geostationary satellites owned by London-based telecommunications company Inmarsat that took place over 16 years of operation.

Geostationary satellites orbit at the same rate as the Earth's rotation, which allows the satellites to maintain a constant location relative to the planet throughout their lifetime while providing access to television, Internet and communication services. Designed to last for up to 15 years, the satellites are heavily shielded to protect sensitive electronic components from solar radiation; however, say MIT researchers, over time radiation can penetrate the shielding and affect the performance of these components.

"If we can understand how the environment affects these satellites and we can design to improve the satellites to be more tolerant, then it would be very beneficial not just in cost, but also in efficiency," Whitney Lohmeyer, a graduate student in MIT's Department of Aeronautics and Astronautics, said. Lohmeyer and Kerri Cahoy, an assistant professor of aeronautics and astronautics, are working together to evaluate how sensitive satellite components are to the weather conditions in space, and how these conditions contribute to satellite failure.

Results from the study indicated that the majority of the Inmarsat satellite failures overlapped with periods of high-energy electron activity during declining phases of the solar cycle. The researchers believe that this particle flux may have accumulated in the satellites over time, creating internal charging that damaged the amplifiers responsible for strengthening and relaying signals back to Earth. While most satellites carry back-up amplifiers, says Lohmeyer, over time this supply may run out.

"Once you get into a 15-year mission, you may run out of redundant amplifiers," she said. "If a company has invested over $200 million in a satellite, they need to be able to assure that it works for that period of time. We really need to improve our method of quantifying and understanding the space environment, so we can better improve design."

Today, engineers design satellites using radiation models to predict how much radiation a satellite in a particular orbital path may be exposed to during its lifetime. But these radiation models aren't perfect, says Cahoy.

"Space weather is a lot more dynamic than models predict, and there are many different ways that charged particles can wreak havoc on your satellite's electronics," she said. "The hard part about satellites is that when something goes wrong, you don't get it back to do analysis and figure out what happened."

As users continue to demand more capabilities, engineers will need to ensure that increasingly complex satellites remain adequately protected from solar radiation. Understanding the connection between space weather conditions and the effects on satellite components will help guide these design improvements.

(From "Satellites Need Better Shielding from Space Weather, Say Researchers" by Aliza Becker in Interference Technology's eNews magazine, 09/17/2013, www.interferencetechnology.com/satellites-need-better-shielding-from-space-weather-say-researchers. See more at: http://web.mit.edu/newsoffice/2013/space-weather-effects-on-satellites-0917.html.)

817) RFI team keeps LTE working

LBA Group, Inc. has announced its technical consultancy unit, Lawrence Behr Associates, Inc., has formed a highly-equipped, rapid response RF interference remediation team to meet the time-sensitive interference mitigation needs of wireless carriers and their customers.

"New LTE systems are very sensitive to interference from sources such as CFL bulbs, FM broadcast transmissions, utility supervisory control and data acquisition (SCADA) systems, and even rusty bolts," Chris Horne, PhD., LBA chief technical officer and leader of the new team, said. "LBA can not only find the source of interference but also help negotiate a solution if the interference source is coming from a third party."

(Taken from "RF Interference Remediation Team Keeps LTE Services Working" published as www.interferencetechnology.com/rf-interference-remediation-team-keeps-lte-services-working on 12/17/2013.)

818) ARRL petitions FCC to shut down BPL in Virginia

The American Radio Relay League (ARRL) has called on the Federal Communications Commission (FCC) to shut down a broadband over powerline (BPL) system currently being operated by ComTek Communications Technology for City of Manassas, Virginia.

The Manassas deployment of a high-speed internet BPL was formally launched last October, approximately one year after the FCC adopted new rules governing the deployment of BPL systems. Proponents of the Manassas system hailed it as "the first large-scale commercial BPL deployed in North America". But the ARRL and others have complained bitterly that the city's system has produced intolerable levels of interference with amateur radio operations, even during the two year trial period leading up to the system's official debut.

According to the ARRL, field tests conducted by both the US Department of the Navy and by radio amateurs located in and around the city have determined that the BPL system "was an interference generator at distances of hundreds of feet from modems on overhead power lines."

In its filing to the FCC's Office of Engineering and Technology (OET) and the agency's Enforcement Bureau, the ARRL argued that "whatever actions either Manassas Power or Communications Technologies Inc. might have taken to relieve the problem have not been successful…the system must be shut down, pending successful resolution of the severe interference."

(Taken from an article of the same name published in Conformity magazine, Jan 2006, www.conformity.com. In the UK, BPL technologies are more usually called powerline communications, PLC.)

819) Electromagnetic Radiation Powers Smartphone Case

A new smartphone case prototype on display at the Consumer Electronics Show in Las Vegas featured a unique way to signal an incoming call that makes use of the cell phone's electromagnetic radiation.

Concepter's Lune smartphone case detects when a call is being received based on the wavelength of the phone's GSM signal and alerts the user by illuminating a ring of green LEDs on the back of the case, using only the phone's electromagnetic field as its power source. The company reportedly declined to reveal the inside of the case or further specifics as to how it functions.

While the prototype case on display was made for an iPhone, Concepter is planning to make versions for other types of phones, as well as install differently colored LEDs for other notifications such as SMS messages. The company is expected to place the Lune smartphone case on crowdfunding website Kickstarter later this month.

(Taken from www.interferencetechnology.com/electromagnetic-radiation-powers-smartphone-case/, Video: VentureBeat, 01/13/2014, also see: http://venturebeat.com/2014/01/08/this-iphone-case-uses-electromagnetic-radiation-to-power-its-led-notification-lights.)

(The Editor says – This sort of thing has been tried before with LEDs that twinkled fitted to cellphone antennas, but they distorted the radiated energy and caused harmonics that were not compatible with the GSM emission standards – see Banana Skin No. 107 in "The first 500 Banana Skins" (available from www.compliance-club.com/BananaSkins.aspx and www.emcacademy.org/books.asp) where it says "Tests carried out by the Radiocommunications agency on two 900 MHz cellphones fitted with twinkling antennas showed that…..the ERP of the second harmonic…..exceeded the ETS 300 577 maximum".)

820) EMI problems and in-situ EMC testing

Performing EMC tests on large electronic equipment can be problematic especially if the EUTs can't be moved. It doesn't matter how large a test chamber may be, some EUTs must be tested in situ. Here are a few examples.

• New York City Hospital magnetic field susceptibility problem: This was caused by an underground subway passing adjacent to a neurosurgical operating room and turned out to be magnetic loop coupling from improper installation.

• RF emissions problems from an induction furnace used for annealing a moving 60-inch web of sheet steel: This turned out to be a radiation hazard issue.

• The tunnel radio system interference within Boston's Big Dig: This was an intermodulation problem.

• An Ohio coal-fired power plant control system susceptibility problem resulting from an instrumentation upgrade from vacuum tubes to solid state: One volt of noise on a 250-V plate supply is not nearly as much of a problem as it is on a 5-V logic device.

• Interference from an unattended telephone switching center in Iowa to local TV reception in a three-block radius when it was changed over from code switches to a computer-controlled digital switching system: More subscriber features, more subscriber problems.

In all of these cases, the system being tested is the combination of the installed EUT and its surrounding RF environment/equipment. Because the installed RF environment is part of the system, tests and examinations have to be done in situ; that is, tested in place. This often happens with large-scale system installations and generally is accompanied by the unexpected.

Everywhere you want to set up an antenna there is a wall, a column, a power line, a piece of equipment, and high-level RF signals that exceed the spec limit for the test. Plus in an industrial environment, the RF ambient always is changing, which makes it extremely difficult to determine what's the EUT and what's ambient.

(Taken from an article entitled "A Look at In Situ EMC Testing - Part 1" by Ron Brewer, EMC/ESD Consultant, in Evaluation Engineering magazine, November 2010, www.evaluationengineering.com/articles/201011/a-look-at-in-situ-emc-testing-part-1.php)

821) Bright Spark

When playing with a piezoelectric spark device from a lighter, I created a spark between it and a radiator and noticed two effects. Firstly, the room lights flickered – the dimmer switch for my lights was partly on and this may be a factor. Second, when I produced the spark, it caused the computer to think that the devices plugged into its USB ports had been removed. Is there any reason for these effects?

(A question posed by Ben Phoenix, in the Last Word column on page 65 of the New Scientist magazine, 14 December 2013, www.newscientist.com/topic/lastword. Yes there is! – Editor.)

822) South-East England in danger of blackouts

Eaton Power Quality's latest Blackout tracker report has shown that the South east of England suffered more power blackouts than any other region in the UK in 2011.

The annual report, which is now available via www.eaton.com/blackoutuk, uses reported power outage information from news services, newspapers, websites and personal accounts to analyse the impact of power outages in the UK.

According to Eaton's research, power outages in the UK have a major impact on businesses and can cause significant productivity and financial losses each time they occur. Over 33% of companies take more than a day to recover and monetary losses range between £12,676 and £316,900. The research also found that 90% of companies that experience a computer disaster and don't have a survival plan, go out of business within 18 months and 15% of businesses experiencing power outages lose over £1.2m.

Eaton's Paul Norgate commented, "The report demonstrates that the best way for businesses to protect themselves is to develop a power protection plan which will help mitigate against the significant losses a power outage can bring. UPSs play a key role in this plan because they effectively offer a form of insurance against power failures. However, like any hardware, it is important to ensure that the specification of the product you use is up to date and therefore ready to cope with the challenges posed by both today's, and tomorrow's, potential outages."

(Taken from the article "South east England in danger of blackouts", in Electrical Engineering magazine, June 2013, www.connectingindustry.com/electricalengineering.)

823) New defibrillators suffer EMI that could threaten patients' lives

Your email reminded me of exactly the sort of problem that you predicted, but was a real threat to the patient's life rather than just the nuisance I described earlier.

My hospital has just got lots of new defibrillators. A patient in the cardiac catheterisation laboratory was having an arrhythmia investigated using a mapping system that used an electro-magnetic positioning system to say where the intra-cardiac catheter was. A ventricular tachycardia was deliberately induced.

When the new defibrillator was switched on, it failed its self check. Subsequent investigation showed that the electro-magnetic positioning system was the cause. Similar models also failed. Older defibrillators did not have the same fault.

Fortunately for the patient, overdrive pacing resolved the arrhythmia as our efficient Medical Physics Department had removed the older defibrillators, which were immune to interference.

The incident is being investigated and you may hear about it through other channels.

(An email to the UK's medical standards BSI committee, from Dr David H T Scott, Pask Certificate of Honour, Consultant Cardiothoracic Anaesthetist and Intensive Care Specialist, Department of Anaesthetics, The Royal Infirmary of Edinburgh, EH16 4SA, reproduced here with his permission. **Note:** *Dr Scott retains the copyright of this text, please contact him at david.scott@ed.ac.uk if you wish to copy or re-use it.)*

824) Real-world transients in automotive power networks are seldom like test specifications

An example of a common problem is simple everyday inductive kickback.

In both theory and in practice, most DUTs that withstand these kinds of immunity test won't have problems once they are built into the vehicle.

However, real-world switching pulses are seldom exactly like the narrowly-defined pulses defined in ISO 7637 or the OEM specifications. Thus, during vehicle-level testing some DUTs that have previously been found to conform to the immunity tests defined therein, experience problems during pulses found in the actual vehicle.

(Taken from the article "Designing an automotive pulsed immunity network" by Tim Horacek of Teseq, in EMC Test magazine, Nov 2012.)

825) Live 4G-Freeview Interference Tests Suggest Better Performance Than Expected

A trial 4G network installed near Birmingham, UK has reportedly performed better than expected, alleviating fears over initial reports released late last year suggesting that up to 2.3 million homes could be affected by interference with the Freeview TV signals.

A total of 15 out of 22,000 households reported issues with their television signals that were determined to be related to interference. All issues were mitigated with the installation of a filter to block 4G signals at 800 MHz. Freeview services utilize the 700 MHz spectrum range.

A second, larger test covering 170,000 households and businesses will take place in southeast London early next week.

“These larger tests are essential to help improve our forecast model and the way we’ll tackle potential issues caused by 4G at 800 MHz. We are extremely grateful to viewers in southeast London for their help with these important tests,” Simon Beresford-Wylie, chief executive of at800, said.

Households experiencing interference with their television signal during the test are asked to contact at800.

(Taken from an article by Aliza Becker posted as www.interferencetechnology.com/live-4g-freeview-interference-tests-suggest-better-performance-than-expected, on 04/11/2013.)

826) Dutch Cable Companies Blame 4G for TV Interference

Cable companies in the Netherlands are claiming 4G wireless networks may be affecting their television broadcast signals.

Certain frequencies used by the fourth generation mobile network technology are also employed by television broadcasters to deliver content over cable, the Netherlands Broadcasting Foundation (NOS) said this week. There have been complaints in some cities about problems with both local and international channels.

Cable customers are reportedly being advised to get better insulated cables to reduce the potential of interference, which could get worse as 4G services expand to more areas of the country, NOS said.

The first 4G services were rolled out in the Netherlands in 2012.

As the wireless technology market continues to grow, interference between TV signals and wireless networks will only increase. In the UK last year, concern over a nationwide 4G network installation stemmed from initial reports that suggested (see article below) up to 2.3 million homes with Freeview cable television service could be affected by interference, while in December customers of Time Warner Cable linked blurry, distorted television screens to nearby use of the Verizon LTE service.

(Taken from an article by Aliza Becker, posted as www.interferencetechnology.com/dutch-cable-companies-blame-4g-tv-interference on 02/12/2014.)

827) Interference with railway track circuits causes rail accidents

In general, the track circuit transmitter of AC railways is fed by DC (Sweden), even harmonic (100 Hz, 6th harmonic of 16 2/3 Hz supply, Switzerland) or inter-harmonics (105 Hz, used in 16 2/3 Hz fed traction system, Norway) and that for DC railways use AC at various frequencies. In some railways, the audio frequency ranges are also used (9.5-14.5 kHz [2]).

The basic assumption behind selecting this type of source as transmitter is that in AC traction system, there will be no DC or even harmonic components and in DC railway, there will be no AC component. Since audio frequency track circuit uses a band quite high compared to the power frequency and its lower order harmonics, it was also assumed that there can not be any interfering high frequency current components at that band originating from the traction power sources. However with time, interference issues were noticed and reported by railway engineers and there have been reports of accidents as well because of the false signalling triggered by the interference between the return current of the train propulsion system and the tracks circuits [78]. In Chapter 5, the presence of DC components and even harmonics because of the arcing in the pantograph is explained. This interfering current could be from other sources like the power electronic drives of the train propulsion system, geomagnetic induced current, interference from track side non railway sources, nearby railways or presence of neighboring industries etc. The false signalling can be classified as [15]:

— False occupancy – Where the signalling system will falsely display red light even if there in no train and

— False unoccupancy – Where a false green light will be displayed (Fig.7.4) although there is a train on the track.

False occupancy is comparatively more common and can lead to reduced reliability, service interruption and delay in operation. false unoccupancy is quite rare, but can result in collisions and accidents which could be disastrous.

As shown in Figs. 1.6(a) and 1.6(b), the track circuit relay coil has to be energized for a green signal and de-energized to make a red signal.

If it is somehow de-energized because of interference current, it will lead to false unoccupancy as shown in Fig. 7.4 and vice versa. For this to happen, the interference current should have the same frequency content as the transmitter and same signal characteristics. As discussed in Chapter 5, the pantograph arcing distorts the current waveform which contains a wide band of harmonic contents, including DC components, even harmonics and inter-harmonics. In general the resulting interference reduces the operational reliability of the functioning of the track circuit.

However to cause interference which may trigger false signalling with the track circuit, the signal characteristics should be identical which is quite uncommon because of different signal processing techniques used in track circuits (modulations techniques coding/decoding etc.).

[78] T. Konefal, D. A. J. Pearce, C. A. Marshman, and L. M. McCormack, \Potential electromagnetic interference to radio services from railways," Final Report, Mar. 2002. [Online]. Available: http://www.yorkemc.co.uk/research/railways.

(Taken from "Conducted and Radiated Electromagnetic Interference in Modern Electrified Railways with Emphasis on Pantograph Arcing", the Doctoral Thesis by Surajit Midya, Doctoral Thesis in Electrical Systems, Stockholm, Sweden 2009, Electromagnetic Engineering, KTH Electrical Engineering, SE-100 44 Stockholm, Sweden, www.etk.ee.kth.se, TRITA-EE 2009:029, ISSN 1653-5146, ISBN 978-91-7415-345-3.)

(Editor – Did you notice the sentence: "For this to happen, the interference current should have the same frequency content as the transmitter and same signal characteristics." Like many (but not all!) engineers in the railway industry, this author assumes that only direct interference can occur – ignoring the possibilities for demodulation and intermodulation to cause interference – also see number 570.)

828) Recent adverse events related to EMI in hospitals in Östergötland, Sweden

Trends

• More and more departments want to use mobile phones in close proximity.

• Manufacturers offer more and more systems that use wireless datacommunications.

• Patients want to use smartphones, computers and video games during treatment.

• The use of energy efficient solutions increase (lights...).

Immunity

• [redacted] (and [redacted]).

• Alarm code 33 intermittent in OR.

• Long time test by DCE (Department of Clinical Engineering) – no alarms.

• Alarm can be triggered by diathermia.

ESD (28/02/11)

• Pulse oximeter.

• Several models of [redacted] experience repeatedly circuit board failure.

• Display shows ERR SpO2.

• Repair by the manufacturer.

• The fault is still present. The manufacturer then adds a little metal part on the connector so the user may be discharged.

• One of the devices sometimes restarts.

• DCE finds that the problem with restart can be repeated by a contact ESD discharge.

• Several units have had this problem.

Emissions (08/07/11)

• When changing the position of the [redacted], [redacted] medical bed, the humidifier ([redacted] [redacted]) alarms. The two alarms indicates problems with the power supply. The alarms stops but the temperature drops from 37° C to 32° C. It takes a long time to rise the temperature to 37° C again. As a result there is much more water collected in the expiratory tube and the respiratory device filter gets filled with water and needs to be change more often than the usual (1 time every 24 h).

• The investigation shows that the problem occurs when the new [redacted] heat cable ([redacted]) is used. The problem does not occur with the old cable ([redacted]).

• The event is not related to humidifier, bed or location, it can be repeated no matter what combination is used.

• The failure can also be repeated even when the equipments are connected to different electrical mains groups.

• The failure can also be repeated in another part (location) of the hospital.

• The only common cause is the new heat cable ([redacted]).

Mobile phone interference (30/05/11)

• Mobile phone interference with patient monitor system ([redacted]).

• Four children in neonatal intensive care emergency room with full monitoring.

• When a parent's mobile phone started to ring all monitors stopped working.

Distorted saturation readings (16/10/10)

• During several occurrences during the night all three patient monitors shows a pulse of 220-250 on the pulse oximetry but normal pulse on the ECG. Control shows normal pulse but the monitor continues to show very high values.

• During the incidents it was observed that a relative was using a 3G modem to connect to the internet instead of using the patient LAN.

ECG disturbance (27/09/10)

• [redacted] patient monitor [redacted] module.

• Interference in the patient monitoring ECG in operation room.

• ECG monitoring is not working correctly. Lots of disturbance and signal only in one lead. We changed all equipment but with no success.

Alarm problem 2006

• Anaesthesia workstation [redacted].

• No sound alarm from the monitor part, disturbance on [redacted] monitor. The alarm sound is very weird during testing. A mobile phone was observed 2-3 m from the anaesthesia workstation.

Telemetry drop outs (present)

• New 2.4GHz telemetry in cardiology department, suffers intermittent drop-outs.

(Copied from "Recent known adverse events related to EMC in Sweden", by Magnus Stridsman, MSc, Safety Manager, Department of Clinical Engineering, County Council of Östergötland, Sweden, which he presented at the meeting of IEC SC62A MT23, held in Carlsbad California on 19-23 March 2012 (MT23 is the IEC Maintenance Team responsible for IEC 60601-1-2: Medical electrical equipment –

Part 1-2: General requirements for basic safety and essential performance – Collateral standard: Electromagnetic disturbances – Requirements and tests, which was published at Edition 4 in February 2014. The names of the medical equipment manufacturers and model numbers concerned have been redacted.)

829) Detecting where IEMI attacks are coming from

Electromagnetic fields can interfere with or damage electronic devices. Electromagnetic radiation is invisible to people. A new measuring instrument can now determine the strength, frequency, and direction of the attack.

The researchers there (at the Fraunhofer Institute for Technological Trend Analysis INT – Editor) are concentrating on the question of how EMP attacks can be detected. They have developed a measurement instrument for this purpose that is capable of determining the strength, frequency, and direction of electromagnetic attacks. The engineering requirements are steep: the detector must measure very high field strengths from very short pulses, yet not be destroyed or damaged itself.

Identifying the type, location, and duration of the attacks

Four specialized antennas make up the INT demonstration instrument that sample the environment around the subject device to be protected. Each of these covers a quadrant of 90 degrees and detects all types of electromagnetic sources. A high-frequency module preconditions the signals for measurement and determines when the electromagnetic pulse started and stopped.

A computer in a monitoring station connected via an optical conductor then calculates the values for the signal and presents them on a screen. “We identify the type and location of the source of the invisible attack as well as its duration as though we had a sixth sense. Those affected by the attack can use this information to mount a rapid and appropriate protective response,” explains Jöster.

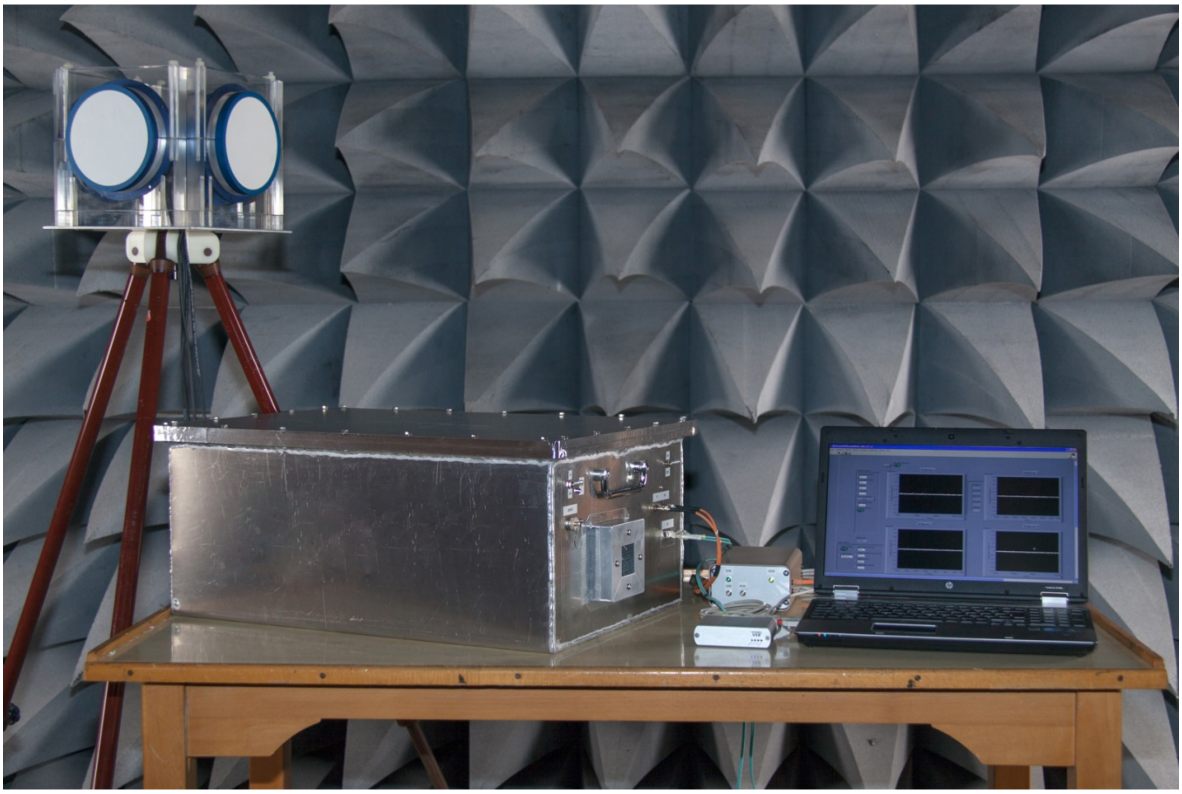


Figure: Tools for defending against electromagnetic attack (right to left): an antenna set (on tripod) for sensing the environment, a RF measuring device for conditioning the signals and a computer that calculates the relevant data.

The threat scenarios are real: criminals disrupt computer networks of banks, exchanges, and companies. They cause confusion in order to bypass monitoring points or overcome alarm systems, enabling them to penetrate into secure areas. Individual cases of these kinds of attacks have already been documented: thieves used electromagnetic waves to crack the security systems of limousines in Berlin. Their weapons are no larger than a suitcase. High-power microwave sources are suitable for those kinds of attacks, for example. Depending on the field strength, the attacker using these high-power microwaves can be located several meters from the target of the attack. "Located In the right position, it is enough to press a button to trigger the pulse. Just like in Ocean's Eleven or Matrix, the electronic systems nearby can fail or be damaged," as Jöster describes the danger.

Electronic devices can withstand a certain amount of radiation. This is measured in volts per meter (V/m) – called the electromagnetic compatibility (EMC). Otherwise, they would not operate reliably. Every device could interfere with others in its immediate vicinity. Depending on the category of usage, they therefore have to fulfil specific EMC requirements. These are significantly higher for industrial applications than for common things like Smartphones, televisions, or stereo equipment.

One example where safety is important is automotive engineering. "The importance of electronic components will continue to increase in the future. Completely shielding individual devices from electromagnetic radiation would certainly be theoretically possible, but much too expensive though. Systems are needed that can detect these kinds of attacks. If you know what is attacking, you can also react correctly to it," according to Jöster.

(Taken from "Defending against electromagnetic attacks" by Michael Jöster of the Fraunhofer Institute for Technological Trend Analysis INT in Euskirchen, just south of Cologne, Germany, in Research News Dec 02, 2013, www.fraunhofer.de/en/press/research-news/2013/december/Defending-against-electromagnetic-attacks.html. This was also reported in an article by Eliza Becker, in Interference Technology's on-line newsletter on 12/03/2013, at www.interferencetechnology.com/new-tool-detects-traces-electromagnetic-attacks. IEMI is the IEC 61000-5-1 acronym for Intentional Electromagnetic Interference.)

830) Always ask, even if the answer seems obvious

Oops – a repeat of number 746, sorry!

831) Exploding harmonic filter capacitor causes Queen Mary 2 to drift for 1 hour

SYNOPSIS

At 0425 on 23 September 2010, as RMS Queen Mary 2 (QM2) was approaching Barcelona, an explosion occurred in the vessel's aft main switchboard room. Within a few seconds, all four propulsion motors shut down, and the vessel blacked out shortly afterwards. Fortunately, the vessel was clear of navigational hazards and drifted in open sea.

The emergency generator started automatically and provided essential supplies to the vessel, and it was quickly established that the explosion had taken place in the aft harmonic filter (HF) room, situated within the aft main switchboard. The aft main switchboard was isolated, main generators were restarted and the ship was able to resume passage at 0523, subsequently berthing in Barcelona at about 0900. No one was injured.

The accident caused extensive damage to the aft HF and surrounding structure. Two water-mist fire suppression spray heads were activated, one in the aft harmonic filter room and the other in the aft main switchboard room.

The explosion was triggered by deterioration in the capacitors in the aft HF. Internal arcing between the capacitor plates developed, which vaporised the dielectric medium causing the internal pressure to increase, until it caused the capacitor casing to rupture. Dielectric fluid vapour sprayed out, igniting and creating the likely conditions for an arc-flash to occur between the 11000 volt bus bars that fed power to the aft HF.

A current imbalance detection system, which was the only means to warn against capacitor deterioration, was found to be inoperable, and it was evident that it had not worked for several years.

The electrical disturbance from the capacitor failure caused its circuit breaker to open and isolate the aft HF from the electrical network. It was not possible to determine the exact cause of the subsequent blackout because the option for storing historical data concerning blackouts was not chosen at build. However, it is considered most likely that the disruption within the aft HF at the time of the accident caused general instability in the electrical network which could not be contained and led to the generators shutting down.

Lloyd’s Register (Europe, Middle East and Asia) (LR) has been recommended to take forward proposals to the International Association of Classification Societies to:

• Establish a requirement for all new vessels fitted with harmonic mitigation equipment to model the effect of its loss and provide data to crew so that appropriate corrective action can be taken in such circumstances.

• Require on-line or periodic monitoring of harmonic distortion of voltage on all vessels with high voltage power systems to give early warning against potential problems.

• Develop requirements to detect and mitigate against the failure of high-energy storage devices and to ensure that protection devices of critical items are fail safe.

The Maritime and Coastguard Agency has been recommended to produce specific guidance regarding the harmful effects of excessive harmonic distortion in electrical networks and to update the Code of Safe Working Practices for Merchant Seamen to raise awareness about the hazards of arc-flash in high voltage equipment.

QM2’s manager, Carnival UK have also been recommended to: improve the standards of protection against the effect of harmonic distortion and component failure; and, to review the machinery alarm systems fitted to QM2 in order to identify and prioritise those alarms which indicate failure conditions that could significantly affect the safety of the vessel.

RMS Queen Mary 2. Photo courtesy of Jörn Prestien.

(Extracts taken from: “Report on the investigation of the catastrophic failure of a capacitor in the aft harmonic filter room on board RMS Queen Mary 2 while approaching Barcelona 23 September 2010. VERY SERIOUS MARINE CASUALTY REPORT NO 28/2011 December 2011” available from http://www.maib.gov.uk/publications/investigation_reports/2011/qm2.cfm, along with a set of Annexes.

Editor – I find it interesting that they had a procedure for checking and recording the current monitors on the harmonic filter capacitors, but no procedure for what to do when their readings were wrong!)

832) Radar interfered with early pacemakers

Dan Hoolihan: Also I think you mentioned to me that in your career you did some work with pacemaker companies and, in general, what kind of testing did you do on those and what kind of results were you looking for?

Jim Toler: Okay. Our introduction to that came through a company called Cordis, a pacemaker manufacturer in Miami, that I am not sure is still in business. But a Dr. Peter Harjean came to Georgia Tech looking for help. His concern was the possibility that pulsed radar systems might, in some way, alter the pulse of an implanted pacemaker. So, Peter made it possible for me to go to a number of medical conferences and meet pacemaker manufacturers. He took me there and introduced me to them. They, then, began to bring their pacemakers to Georgia Tech for EMI or EMC evaluations.

We struggled with how to test them. Out in just the air is not anything close to their normal installation location. So we devised a solution of saline to kind of represent, at least a composite, of body tissues and put them in a saline solution and put the lead out horizontally. We had a number of different high-powered radar systems at Georgia Tech so we exposed them to that environment in that kind of a solution. Interestingly, the first test involved a unit that was the largest — world's largest — sales unit. In terms of sales volume it was the world's best pacemaker. When we turned on the first radar, the pulse rate of the radar altered the pulse rate of the pacemaker.

Dan Hoolihan: Not so good.

Jim Toler: So we began working then with pacemaker design as well as pacemaker testing. The design problems were not overpowering, they basically involved conventional filtering and shielding, but it had to be done in a biologically compatible [way] with tissue. That all had to be a consideration. So, we wound up with a rather extensive testing program for pacemaker manufacturers, both here and abroad. It was a learning experience for all of us and I made some very good friends in the process.

Dan Hoolihan: Did you also, then, get involved with the, for example, microwave oven issue? Microwave ovens and pacemakers?

How was your research with radars related to that?

Jim Toler: The microwave oven is, of course, a continuous wave field, not a pulsed wave field. So we had suspicions from the beginning that their effect might not be as great from microwave ovens. Although, those were the things that were feared at the time. But, we had an array of microwave ovens, and the tests began with the door closed. Then the door was opened by a certain amount and radiation levels went up, of course. Then opened by more and more. And pacemakers weren't, generally, interfered with by microwave ovens. We pretty well proved that and established that point and relieved some of the concern with the microwave oven exposure. It was a public concern at the time, but not so much from technical or engineering point of views.

(Extracts taken from: "Interview with Jim Toler at the 2013 IEEE International Symposium on EMC" by Dan Hoolihan under the pen name "Espresso Engineering", published in the 2014 IEEE Electromagnetic Compatibility Magazine – Volume 3 – Quarter 1, available from http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6798791)

833) Pennsylvania Voting Machine Malfunction EMI Related?

The recent election night proved to be a test for even the most determined voters. In addition to the long, slow-moving polling lines and the haphazard solutions put hastily into place for hurricane-ravaged areas of the Northeast, voters were also subjected to electronic voting machine malfunctions in several states across the country. In Pennsylvania, a voting machine was "taken out of service" after a YouTube video published by user "centralpavote" revealed the machine's touch screen incorrectly registering votes for President Barack Obama as votes for Republican presidential candidate Mitt Romney.

The video submitter explains in the description section for the video that he attempted to select the checkbox beside President Obama's name several times and each time, Romney's name was highlighted instead.

"Being a software developer, I immediately went into troubleshoot mode. I first thought the calibration was off and tried selecting Jill Stein to actually highlight Obama. Nope … I asked the voter on either side of me if they had any problems and they reported they did not," he said.

According to Alfred Poor, a display technology expert and a contributing editor with Information Display, many electronic devices equipped with a touch screen utilize a technology known as "projected capacitance" that relies on the build-up and exchange of an electrical charge between two conductors and "the fact that an electromagnetic field 'projects' above the plane of the conductive sensor layer."

Even covering the touch module with a sheet of glass will not inhibit its ability to sense when a conductor is near. Poor explains that "when you touch the screen with your finger, it steals a little of the charge from each layer of conductors at that point … because each conductor is checked separately, it is possible to identify multiple simultaneous touch points."

However, Poor cautions that the system of conductors "is susceptible to electrical noise from electromagnetic interference" and can misread which signals are from actual touch points, resulting in possible unintended performance of the electronic device.

At this time, officials have not determined the cause of the electronic voting machine malfunction in Pennsylvania.

(Taken from www.interferencetechnology.com/pennsylvania-voting-machine-malfunction-emi-related, 11/08/2012. For more information, visit The Raw Story: www.rawstory.com/rs/2012/11/06/pa-voting-machine-taken-out-of-service-for-flipping-votes-to-romney-report and PC Advisor (http://www.pcadvisor.co.uk/news/digital-home/3405657/how-it-works-technology-of-touch-screens/).

834) LED street lamps interfere with TV and radio in Japan

Actually, in 2010, poor reception of analogue TV and audio broadcasting occurred after LED lamps were installed in a shopping street in Japan [2] .

(Taken from "Measurement and Modelling of Electromagnetic Noise from LED Light Bulbs" by Y Matsumoto et al in the 2013 IEEE Electromagnetic Compatibility Magazine – Volume 2 – Quarter 4, available from http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6714699. Reference [2] is [2] S. Kanno, N. Hirasawa and Y. Akiyama, "A study on the correlation between common mode voltage measured by using CDNE and radiated electromagnetic field strength emitted from LED bulbs>>, IEICE Tech. Rep., EMCJ 2011-12, pp. 13-17, Dec. 2011".)

835) Good reasons for using fibre-optical cables to solve industrial EMI

Fiber optic solutions are immune to electromagnetic interference (EMI), spikes, surges and ground loops. The data isn't traveling along a copper wire; it's carried by a beam of light. This is invaluable in industrial applications, for example, where the electric motors on the machinery can generate powerful magnetic fields. Wi-Fi and cellular networking confer similar advantages.

But remember that extending your data communications range via copper wire increases the risk for unwanted electrical events. The greater the distance between connected devices, the more likely it is that they will have different building ground references and the associated risk for ground loops. If the cable is installed in an industrial environment and passing machinery along the way, greater range also creates more opportunities for EMI.

Copper wire networks should be protected with surge suppression and isolation. Surge suppressors limit spikes between the signal and ground line and should be deployed as a first line of defense on power supply lines. Current models can be DIN rail mounted or connected directly to a cabinet, with surge protection ratings of up to 39 kA and less than 1 ns response time.

But when the ground line rises, as it does in ground loop events, you'll need isolation. Isolators convert data signals either to pulses of light or an electrical field, and then back again. Spikes and surges are stopped at the isolation zone. Isolators protect power lines by transforming VDC power to AC, then back again.

(An extract from: "Five options to extend reach of your Ethernet network" by Mike Fahrion, who is the director of product management at B&B Electronics www.bb-elec.com, published in the Industrial Ethernet Book Issue 79 / 46, November 2013, pages 36-37, available at

http://www.iebmedia.com/index.php?id=9869&parentid=63&themeid=255&hft=79&showdetail=true&bb=1.)

836) US Navy problems with EMI in 1955

Radiofrequency interference (RFI) is caused by some machine tools and portable tools, as well as by induction heaters and RF stabilized arc welders. The newer types of electronic-controlled machine tools can be the victims of RFI. It is a coming problem in the metalworking field, and forebodes trouble for those who ignore the possibilities. Although there has been much work done on interference for many years, the machine-tool phase of RFI started about 1½ years ago…

By the time radio interference from welders and induction heaters became a recognized and fairly well controlled problem, Navy engineers working with highly sensitive receiving equipment found that something was still causing trouble.

Interference can be generated by any number of electrical disturbances – both natural and man-made. But this specific interference was traced to certain kinds of electrical equipment associated with some machine tools.

MANY FORMS

Interference can take many forms, and can be caused by a wide range of electrical devices, including regular radio broadcasting and receiving equipment. However, there are few cases where broadcasting stations or amateur transmitters are major offenders because each is assigned its own frequency or band on which to operate. If the station strays, the operator is sure to hear about it.

The source of most of the trouble caused by machine tools is from electrical devices which produce current surges that radiate on frequencies used by regular broadcasters or the Navy.

These can be sparks between switch contacts, hums from induction mechanisms, static from buzzers, and other similar racket. Much of this is simply side effects from the mechanisms; not particularly desirable to the machine owner, but doing (he may think) no harm.

But it does. Generated RFI is transmitted like a regular radio signal, and can be received by regular radio equipment.

DISTANT DISRUPTION

An interference signal from an industrial plant may ruin ground-to-air communications at an airport many miles away. The pilot of a plane using ILA (Instrument Landing Approach) or GCA (Ground-Controlled Approach) would be helpless if uncontrolled interference were to blanket out his communications.

There is one case on record, among many, where an electronic device in an Oregon plant disrupted air-to-ground communications in Georgia.

SPARKING

Most “electrical noise” is caused by sudden changes in the flow of electricity, sparking, or current surging – which often produce undesirable effects. If sparking is designed out of the system, control devices can be simplified.

One good example of this is in fluorescent lamp starters, long a source of erratic RF noise and a product that needed improvement. One small company, working on fluorescent lamp designs, developed an improved and RFI-free lamp fixture. It was found that lamps in this design lasted several times as long as ordinary fluorescent lamps and the company now sell them for applications where interference is undesirable.

Interference is not just a Navy problem, although the Navy has done considerable research on the subject and is relatively well informed. The problem of interference affects many industries and many kinds of equipment.

CURRENT SURGES

For example, the Navy found that some of their computers came up with impossible answers to problems. After a lot of digging around, they found that arcing fluorescent lamps were sending current surges back into the power line, where they were picked up by the computing machines and added into columns of figures. The computing machines were what might be called extremely vulnerable in this case and it has been possible to redesign their control systems so that they do not pick up line interference and convert it into false answers.

There is a silly side to RFI, too. A New York paper reported that a hotel guest was almost convinced his room had a ghost. Actually, his hearing aid was picking up a radio call for a bellboy, sent out by the inside radio system at the hotel.

The hearing aid should not have been able to receive radio calls – it is supposed to be an amplifier, and no more. No doubt, it has long since been repaired and adjusted.

(Extracts taken from: "Radiofrequency Interference—A Problem of Automatic Machine Control" by Charles D. Emerson, Associate Editor, American Machinist and Leonard W. Thomas, Interference Reduction Section, Bureau of Ships, from Bureau of Ships Journal, May 1956, as adapted from American Machinist, November 7, 1955 – as republished in "Quasies and Peaks" in the 2013 IEEE Electromagnetic Compatibility Magazine – Volume 2 – Quarter 4, available from: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6714693.)

837) Effects of RFID emissions in Health Care

By early 2009, the auto-ID industry association hopes to publish a set of methodologies that can be used to determine the impact of tag and reader transmissions on medical devices, drugs, blood and human physiology.

"There have been a number of different studies or tests done [studying the effects of RF in health-care settings]," says Dan Mullen, AIM Global's president, "and to the members of the REG's credit, we have decided to create a set of test protocols that are repeatable and consistent that the industry can look at and use to determine whether there are any concerns or issues."

Mullen cites several studies unveiled in July—particularly one conducted by researchers at Indiana University Purdue University Indianapolis (IUPUI) and by RFID consulting and systems integration firm BlueBean, and another conducted by researchers at the University of Amsterdam's Academic Medical Center in the Netherlands as part of a government research project, and published in the Journal of the American Medical Association (JAMA).

Both studies examined whether electromagnetic radiation from RFID systems would disrupt infusion pumps, EKG monitors and other medical equipment. Their findings, however, differed. The IUPUI/BlueBean study discovered no problems with electromagnetic interference (EMI) (see New RFID Study Finds No Interference With Medical Devices), while the Dutch study did find incidents of EMI by RFID on critical-care equipment in a non-clinical setting (see Researchers Warn RFID May Disrupt Medical Equipment).

"At a certain point, we realized we needed to do something about this," says Craig Harmon, the REG chairperson, and president and CEO of Q.E.D. Systems. Harmon says he and others had received a number of calls regarding the IUPUI/BlueBean and University of Amsterdam studies, and that industry concern greatly spurred action by AIM Global. The organization initially felt the U.S. Food and Drug Administration (FDA) should lead the effort, but later changed its mind upon meeting with FDA representatives who acknowledged such an initiative could take two or three years.

"We can't afford to wait that long," Harmon says. "I'm not aware of anyone who is saying RFID is being banned in hospitals, but I have heard—and this is more rumor than being able to point to one specific example—that some health-care organizations are delaying the use of the technology."

The REG will develop three test protocol suites: one for medical devices (implantables and wearables); a second for clinical instrument susceptibility; and a third for pharmaceuticals, biologics, blood products and human physiology. The protocols will initially focus on radio frequency identification systems based on any of 11 different RFID standards, including ISO 11785 (which employs the 125 kHz frequency band), ISO 14443 and ISO 15693 (13.56 MHz), and ISO 18000-6C and EPC Gen 2 (860-960 MHz), as well as IEEE 802.11, or Wi-Fi (2.45 GHz).

To accomplish its mission, the REG will collaborate with three leading universities in the field of RFID: Georgia Institute of Technology, the University of Pittsburgh and the University of Texas at Arlington. The group hopes to have test protocols ready in the next six months or so, Harmon says, but the effort will take time.

Once the REG completes its work on the test protocols, it plans to submit them to the FDA for comment and approval. AIM then hopes to make the test protocols available to testing facilities, labs and universities. Details are still being worked out in terms of how the protocols will be licensed, but Harmon says that under collaboration agreements, the protocols will be owned by the companies and university participants directly involved in their development—though who these would be has not yet been determined.

*(Extracts taken from: "AIM Global to Develop Protocols for Testing Effects of RFID Emissions in Health Care" by Beth Bacheldor in the RFID Journal, www.rfidjournal.com/articles/view?4384. **Note:** on 23 December 2016 the FDA recognised AIM Rev. 1.00 20160822, '*Medical Electrical Equipment And System Electromagnetic Immunity Test For Exposure To Radio Frequency Identification Readers*'.)*

838) Documented Criminal Usage of Electromagnetic Tools

In 1999 URSI Commission E defined criminal activities using electromagnetic tools as an intentional malicious generation of electromagnetic energy introducing noise or signals into electric and electronic systems, thus disrupting, confusing or damaging these systems for terrorist or criminal purposes. In order to underline the intentional character the electromagnetic compatibility community coined for these kinds of actions the term Intentional Electromagnetic Interference (IEMI).

Public literature [2, 3, 4] has reported eight criminal usages of electromagnetic tools:

1. In Japan, criminals used an EM disruptor to interfere with the computer of a gaming machine and falsely triggered a win.
2. In St. Petersburg, a criminal used an EM disruptor to disable a security system of a jeweler store. The reports mentioned that building the EM disruptor posed a technological challenge similar to assemble a home microwave oven.
3. In Kizlyar, Dagestan, Russia, Chechen rebel command disabled police radio communication using RF jammers during a raid.
4. In multiple European cities (e.g. Berlin) criminals used GSM-Jammers to disable the security system of limousines.
5. In Russia, Chechen rebels used an EM disruptor to defeat a security system and gain access to a controlled area.
6. In London, UK, a city bank was the target of a blackmail attempt whereby the use of EM disruptors was threatened to be used against the banks IT-system.
7. In the Netherlands an individual disrupted a local bank IT network because he was refused loan. He constructed a briefcase-size EM disruptor, which he learned how to build from the internet. Bank officials did not realize that they had been attacked or what had caused the disruption until the assailant was caught.
8. In Moscow, the normal work of one automatic telephone exchange station has been stopped as a result of remote injection of a voltage in to a telephone line. As a result two hundred thousand people had no phone connection for one day.

There have also been several documented incidents caused by EM devices that could be employed by criminals or terrorists [2, 5]. On the target side results of susceptibility investigations as well as reports on observed electromagnetic effects show that IEMI attacks might result in serious consequences or catastrophic situations.

…..In the cases of the suppressed police radio communication as well as the Russian security system the consequences are unknown. In case 2 and 4 the IEMI attacks resulted in some economic loss, as intended by criminals. The case of IEMI attack on the computer system of the NL bank resulted in more serious consequences. In addition to repair costs and loss of data, the loss of confidence in the reliability of the bank resulted in a long term economic damage. The situation was worsened by the fact that the IEMI attack has been undetected for a certain period of time.

…….The IEMI cases presented clearly point out that today the threat by (criminal) IEMI attacks on electronic systems already exists. IEMI sources and their components are available on the free market and the knowledge needed for the assembly as well as the operation can be gained from open literature and the internet. Available IEMI sources are small and highly mobile, e.g. they are able to come close to the target systems. Those systems generate an EM environment that is capable to cause at least a malfunction or (temporary) set up of electronic components. The caused effects might be used to prepare the actual criminal activity.

As electromagnetic fields propagate through material without any alteration of the material IEMI attacks barely leave useful and provable traces. In addition, the complexity of systems often hinders error analysis and received error pattern point to internal causes. Build in test systems are optimized to identify internal errors and malfunctions. As a consequence unpredicted conditions will be mapped to predicted (internal) errors.

A user of a system which is subjected to IEMI environment is unlikely to have any sensation or perception of the (external) electromagnetic stress. With the lack of an indication of the threat and in combination with misleading error patterns the user is perhaps more likely to blame faulty hardware or software errors, rather than an ongoing IEMI attack. Consequently, any IEMI counterattack measure depends on a monitoring of the (external) electromagnetic fields that enables an independent indication of high electromagnetic stress that belongs to IEMI attacks.

(Three extracts from: "What can be learned from documented Intentional Electromagnetic Interference (IEMI) Attacks?" by Frank Sabath, Federal Ministry of Defense, Armament Directorate IV 6, Fontainengraben 150, 53123 Bonn, Germany, Frank.Sabath@ieee.org,presented at the General Assembly and Scientific Symposium, 2011 XXXth URSI , vol., no., pp.1-4, 13-20 Aug.2011, available from www.ursi.org/proceedings/procGA11/ursi/E03-9.pdf.)

839) NATO Denies Involvement in Aircraft Radar Jamming

A statement from NATO made public last week denies involvement in the brief disappearance of dozens of aircraft from air traffic control radars in several European countries earlier this month.

Air-traffic controllers in Austria, Germany, Slovakia and the Czech Republic reported data on the position, direction, height and speed of aircraft disappeared temporarily from radar systems on June 5 and June 10. The outages posed no serious danger to people on the aircraft travelling at high altitude.

"We saw random outages of aircraft detection within the system of the so-called secondary radar lasting several tens of seconds and up to several minutes. But, thanks to the complete coverage of air space also through classic primary radars, we constantly had information about the positioning of airplanes and operational safety was not threatened," Richard Kilma, spokesman for the Czech Air Navigation Service, told Reuters.

An Austro Control spokesman said 13 planes crossing Austrian airspace were affected—10 in the first incident and three in the second—but that he heard 50 aircraft in total were impacted across Europe. Austrian air-traffic controllers handled the outage by communicating with the planes by radio and taking steps to ensure continued air traffic safety, including increasing the distances between planes.

The Slovak state Air Traffic Services company claimed the problem was connected to a planned military exercise with the goal of interrupting radio-communication frequencies.

"This activity also caused the temporary disappearance of several targets on the radar display, while in the meantime the planes were in radio contact with air traffic controllers and continued in their flight normally."

"Immediately after the identification of the problem with the displays, the side organizing the exercises was contacted and the exercise was stopped."

It did not identify the military force in question, which Austrian media said was the NATO western military alliance.

NATO, in response to a request for comment from Reuters, said that training involving "localized and low-power jamming" was conducted over Hungary during the June 2-6, but denied any jamming exercises on June 5.

"Our assessment is that NATO did not cause any interference with civilian air traffic control frequencies. When NATO conducts such exercises, we coordinate our activities with relevant civilian authorities and only use frequencies provided to us by the host nation," a NATO military officer said.

In the wake of the disappearance of Malaysian Airlines flight MH370 in March, there has been a growing focus on improving the tracking of passenger aircraft. At a Meeting in May, The International Civil Aviation Organization (ICAO) set a September deadline for implementation plans for temporary solutions announced it will begin considering new international standards to improve airline flight tracking in the long-term. Other technologies, such as satellite tracking technology, have also been brought to the forefront as a possible replacement for more traditional approaches.

The incidents are reportedly being handled by Eurocontrol, the European air navigation safety organization, and EASA, the European air safety agency.

(Copied from "NATO Denies Involvement in Aircraft Radar Jamming", in Interference Technology's on-line magazine, 25th June 2014, www.interferencetechnology.com/nato-denies-involvement-aircraft-radar-jamming.)

840) Who or what jammed the remote controls in Cowper Way?

A problem for people living in a cul-de-sac in Southcote was pressing all their buttons, but they didn't have the remotest idea what was wrong. Using the TV remote control indoors in Cowper Way was fine, but using a remote control outside simply did not work.

People living in the cul-de-sac, which runs right up to the railway line, naturally blamed a Network Rail communications mast which looms over the area.

Mike Cooper, 63, retired, of Cowper Way, said last week: "We think the mast is jamming the signal. It has been going on for about two years. It comes and goes. About two weeks ago the problem came back and nothing would work. You can't use a remote control for the garage door or for the security lights outside. You also can't lock the car doors with the ignition key until you are standing right by the car – so what is the point of that?"

Mr Cooper's biggest problem was caused by the garage doors which would not open at all. He said: "Fortunately I had not put my car inside, otherwise I would have really been stuck."

But Geoff Ifferlif, 70, who also lives in the cul-de-sac said on Monday: "It seems to have stated working again now, but none of the remote controls worked for about a week and a half. Of course, British Rail (Network Rail) say it is not their fault, We can't prove it is them, but it seems to be the only explanation." A number of people living in the cul-de-sac have made complaints to Network Rail in the past about the problem.

However, next door neighbour Matt Gower revealed this this week that the problem may well lie elsewhere. He told the Reading Post that the glitch rang a bell with a BT engineer, who suggested it might be caused by an electronic doorbell. Mr Gower said: "Everything is all right now, I think they found it was the doorbell that was doing it and have fixed it."

A Network Rail spokeswoman Anne Marie Batson said, when the matter was first raised: "That's a new one on me but I'll ask the question." She later came to say the issue appeared to have been resolved and their equipment was not to blame.

(From the article "Not remotely amused by a jammed signal…" by Linda Fort in the Reading Post dated 7th April 2014, kindly sent in by John Davies (the Editor of the EMC Journal).)

841) Rolling stock EMI study aims to update railway standards (1)

As part of a recently-completed European Union study on the effects of multi-source electromagnetic interference on trains, a British consulting company has helped redesign the way that conformance to railway electromagnetic compatibility (EMC) standards is determined.

The project in question, a two-year study known as TREND (Test of Rolling Stock Electromagnetic Compatibility for Cross-Domain Interoperability), arose from the need to address the electromagnetic emissions from rolling stock (or wheeled vehicles), as well as from electronics on-board trains and from nearby structures, that can affect. These emissions can cause aggravating and even dangerous interoperability issues that affect railway signaling systems, and are insufficiently addressed by current EN50121 European standards.

TREND's goals, as stated on the project's website, were twofold: to design "a test setup that enables the harmonization of freight and passengers rolling stock approval tests for electromagnetic compatibility (EMC) focusing not only on interferences with broadcasting services but also on railway signaling systems," and to "identify and design the cross acceptance test sites on electrified and non-electrified lines that reproduce representative worst case conditions for steady state and transient behaviors."

These "worst-case conditions," such as pantograph bouncing or transients caused by discontinuities in the feeding or track circuit systems, were of particular importance to the project, as such scenarios receive minimal attention from current European standards despite causing significant problems on railways that waste precious time and resources and create dangerous safety conditions due to lapses in signaling.

According to TREND, the stakes for this project are high, as "the previously commented problems might cause an estimated reduction of 10 percent of the availability in the most crowded lines."

Engineers at York EMC Services (YES), an engineering consultancy in York, England partnered with TREND to test and evaluate existing EMC standards, as well as the worst-case conditions that might slip past them.

"Even in trains that are tested fully to the EN50121 series of EMC standards and pass, problems can arise when in service. If this should occur, the technical solutions are not always straightforward," Rob Armstrong, Ph.D, consultant engineer at YES said in an editorial published in Rail Engineer. "In addition, the question of who is responsible for the lack of compliance can be difficult to answer and agree on; for example, is the rolling stock manufacturer responsible due to excess emissions, or the infrastructure manufacturer for inadequate immunity?"

Eva Karadimou, an EMC engineer at YES, told Engineering & Technology. "We looked at 900 MHz because that's used for GSM, and also at 1.5 GHz. The standard covers up to 1 GHz, and we wanted to see if there's a need to go above that. We've shown that there is."

(Taken from: "Study Highlights Need to Re-Evaluate Railway EMC Standards" by Melanie Abeygunawardana, in Interference Technology's online magazine, 24th June 2014, www.interferencetechnology.com/study-highlights-need-to-re-evaluate-railway-emc-standards)

842) Rolling stock EMI study aims to update railway standards (2)

Currently rolling stock electromagnetic emissions is a major concern for train manufacturers and railway infrastructure operators. Available harmonized EMC standards (EN50121-2, EN50121-3-1 and EN50121-3-2) do not completely address interoperability issues caused by rolling stock interferences with signalling systems (GSM-R, BTM, LTM) and even with broadcasting and identification signals such as DVB, WiFi, RFID, for instance. Moreover, these standards do not cover representative worst-case conditions derived by transients in the rolling stock behaviour typically generated by feeding and track circuits' discontinuities.

On one hand this situation causes an important waste of time and resources for train manufacturers when integrating rolling stocks and signalling systems. And moreover in already tested trains, occasionally problems may still arise. Then, not only the responsibilities but also the technical solutions are not straight forward. The duration of the field testing employed to solve this kind of problems and to go through the certification process may vary between 3 months and 12 months. And the cost of the complete process may vary between 25k€ to 1,5M€.

On the other hand, railway infrastructure operators suffer the railway infrastructure availability reduction caused by the rolling stock electromagnetic incompatibility with the safety critical signalling systems. The previously commented problems might cause an estimated reduction of 10% of the availability in the most crowded lines.

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(Extracts from the document available from CEIT: www.ceit.es/en/areas-of-r-a-d/electronics-and-communications/embedded-systems-a-networks/test-of-rolling-stock-electromagnetic-compatibility-for-cross-domain-interoperability-trend)

843) Railway EMI Case Study on emissions from a 25kV overhead

This section aims to highlight the previously illustrated point that detailed interference at a distance from a metropolitan railway in the UK. This is based on a report written for OFCOM in 2002 by York EMC Services [9].

The Urban Transport Study Group (UTSG), which is a subset of TC9X (relevant CENELEC study group for EMC in Railways) was set up to look at issues relating to urban light rail schemes where the separation between the railway and the potential non-railway victim system is typically much less than for a main line railway.

For example, in a light rail scheme like the Manchester Metro, the trams can run along specially equipped public roads. In this case, emissions from the tram system were found to cause audible interference to LW and MW broadcasts at distances less than about 20m from the tramlines. At distances over 30m, the interference had dropped below the noise floor. The issue was identified by hearing audible interference at a specified separation distance between non-railway victim system and the light rail line.

In order to mitigate the EMC problems, theoretical studies were conducted to analyse the issues. The scope included LW, MW, FM, and DAB broadcasting radio technologies.

CISPR 18-2 contains general information about the effects of interference on AM broadcasting. It is likely that a signal-to-interference ratio of around 20dB would be required to prevent any noticeable degradation in the quality of the reception, whereas a signal-to-interference ratio of around 10dB may be required before complaints are received.

The minimum usable field strength for LW and MW broadcasting in Europe is around 1mV/m (60dBμV/m) [8], so the absolute limits on the interference are 40dBμV/m for no significant degradation to sound quality, and 50dBμV/m for a level of interference likely to produce complaints.

The minimum recommended signal strength for FM reception in the absence of interference is 48dBμV/m [9]. In large cities this figure increases to 74dBμV/m, and in rural areas to 54dBμV/m (these figures conform to CISPR-22 standards: this does not include railways). However, in the UK, a minimum signal level of 60dBμV/m is normally assumed.

Digital Audio Broadcasting has received signal strength of 35dBμV/m, but a protection ratio requirement of only 6.5dB, so that interference levels of around 28.5dBμV/m should be tolerable without significant degradation in service.

A non-adequate separation between the Light Railway network and non-railway equipment, combined with high emissions from the Railway were found to be the main culprits involved in this particular case. It is worth noting that the emissions from the railway were still below the relevant EN50121 limits.

[9] Potential Electromagnetic Interference to Radio Services from Railways, Final Report (AY4110) T. Konefal, D. A.J. Pearce, C.A. Marshman, L.M. McCormack, York EMC Services for the Radiocommunications Agency 2002. (Note: reference [9] in the actual report is incorrect. The correct reference is given here - Editor.)

(Taken from "4.4.1. Case Study on emissions from a 25kV overhead" in TREND – TEST OF ROLLING STOCK ELECTROMAGNETIC COMPATIBILITY FOR CROSS-DOMAIN INTEROPERABILITY, REPORT D5.3, D5.4 and D5.5 Representative worst case condition, Representative worst case rolling stock condition, Conditions and limits of rolling stock emission". Report date : 30 April 2013m. Author(s): Iñigo Adin, Juan Melendez, Virginie Deniau, Hassene Fridhi, Rob Armstrong, Eva Karadimou and Emilio Rodriguez. Partners contributed : CEIT, IFSTTAR, Y-EMC, LTU. Contact: Iñigo Adin, CEIT, iadin@ceit.es, download from www.trend-eu.org/deliverables/resultsdeliverables.html)

844) Drawbacks of the EN 50121-x series of EMC test standards

16.2.2. Transient and Continuous Emissions

One of the main outcomes from the 2002 report [13] is the conclusion that the limits present in the EN50121-X: 2000 standard are insufficient to ensure compatibility with existing radio services. Most influences are covered, but the limits are deemed to not be sufficient. Since the introduction of the 2006 version of the EN-50121 series of standards, the emission limits stated in part 2 have not changed.

The limits given in the EN50121-2 are derived from trackside measurements of emissions from moving trains and as such are a combination of transient and continuous emissions; the transient emissions (for example, due to pantograph bounce) may be significantly larger in amplitude than the continuous emissions. However, EN50121-2 actually means that rolling stock manufacturers can legitimately allow continuous emissions (my emphasis – Editor) to emanate from rolling stock up to these limits.

If rolling stock does emit continuously at the appropriate limit then the chance of interference to radio services is greatly increased, as shown in the study [14], where interference was predicted 15km away from a 25kV AC railway, on FM radio services, using the limit from EN50121-2. The rolling stock rarely emits continuously at a level that causes severe interference to broadcasting services, as if that were the case then reported interference cases would be much higher. The fact that reported issues are low suggests that the emissions that interfere with broadcasting services are transient in nature. The problem arises if the rolling stock emits continuously below the limit but high enough to interfere with broadcasting services, which with the current limits is possible.

In an attempt to reduce this problem, the 2006 standard introduced a stationary emissions requirement in order to separate the transient and continuous emissions, as the stationary test allows the use of the quasi-peak measurement system, which is much more useful for measuring disturbance to radio systems. However this does not solve the issue of separating the transient and continuous emissions for the moving train test.

16.2.3. On board systems, RFID, WIFI and GSM

On board systems operating in the radio frequency region (such as freight RFID and WIFI) come under the heading of 'intentional transmitters' and as such are not required to meet emissions limits set out in EN-50121. However, there is no mention within the EN50121 series of standards of the interference effects when using these systems.

Interference from broadcasting services that affect the railway system (i.e. rolling stock immunity) on board the train is severely lacking in the EN-50121 standard set. There is no provision for protection from mobile phones within the passenger compartment other than the assumption (not stated) that any passenger borne equipment would have passed the relevant emission requirements. On board WIFI is not mentioned at all on the European standards, although in some cases the WIFI frequencies are within an OFCOM (Office of communications) designated unrestricted band, meaning there is no limit on emissions in these bands [13]. However, there is still potential to interfere at these unrestricted frequencies and therefore a need for on-board train immunity testing; this is missing from the current standard. There are immunity limits for mobile telephony with regards to interference to signalling and telecommunication systems (in EN50121-4) but not regarding on-board immunity.

The signalling and telecommunication standard (EN-50121-4) is set up to allow immunity testing at mobile telephony frequencies, however the standard only requires testing up to 2.5GHz, which does not encompass the new 4G mobile networks at 2.6GHz or 802.11a at 5.2 GHz. Emission limits from the railway system as a whole (EN-50121-2) are applied from 9kHz to 1GHz, there being no guidelines on limits above 1GHz and therefore potential for interference onto any system that utilises higher frequencies, such as mobile telephony upper bands, 3G and 4G, and both onboard and station based wireless systems. Throughout the EN50121 series of standards, emission limits are defined for lower top frequencies than for immunity levels, except in the case where immunity limits are not present, for example immunity of the whole train.

Etc….

18.1 Drawbacks of EMC Standards

The flexibility of the EN50121-X: 2006 series of standards could be seen as an advantage, as it is easier to obtain the conditions according to the standard for the tests to be done. However, it is not given that new vehicles tested according to EN 50121 will not have EMC problems when introduced onto existing networks. Etc….

[13] Potential Electromagnetic Interference to Radio Services from Railways, Final Report (AY4110) T. Konefal, D. A.J. Pearce, C.A. Marshman, L.M. McCormack, York EMC Services for the Radiocommunications Agency 2002. (Note: the reference [13] listed in the actual report is incorrect – the correct reference is given here. Also, there are three places in the text where a different document is referenced as [14], but the document actually listed as [14] at the end of the report is not one of them! I haven't checked out the other references - Editor.)

(Extracts from "TREND – TEST OF ROLLING STOCK ELECTROMAGNETIC COMPATIBILITY FOR CROSS-DOMAIN INTEROPERABILITY, REPORT D.3.1 and D3.2: Drawbacks of Current Harmonised EMC Approval Tests & Other electromagnetic influences." Report date: 24 February 2012. Author(s): V. Deniau, J. Rodriguez, S. Niska, D. Galar,, A. Morant,, Å. Wisten, I. Adin, R. Armstrong, Partners contributed : IFSTTAR, CAF, TV, LTU, CEIT, Y-EMC, Contact : Diego Galar, Technical University of Luleå, SE-971 87 LULEÅ Sweden, +46 920 49 24 37, Diego.galar@ltu.se. Downloaded from: www.trend-eu.org/deliverables/resultsdeliverables.html)

845) Cars 'possessed' as locks turn on and off by themselves

Car owners in Cornwall have claimed their vehicles are "possessed" after their locking system began turning on and off on their accord, trapping one child inside and leaving many stranded without transport.

Residents of Summercourt, a small village near Newquay, claim the community has been struck by paranormal activity with around 30 cars locking and unlocking themselves.

The bizarre occurrences, which have seen the village dubbed the "Summercourt Triangle" in reference to Bermuda, began six months ago and have been explained by radio interference.

Mike Parris, an expert from car technology firm SBD, said remote locking systems are vulnerable to interruption and that the Cornwall incidents were not unique.

He said: The most probable cause is accidental radio interference, which is not unheard of.

(Taken from an article of the same name by Oliver Duggan, 3:19PM BST 06 Jun 2014, www.telegraph.co.uk/motoring/news/10881319/Cars-possessed-as-locks-turn-on-and-off-by-themselves.html. In the paper copy delivered on 7th June, this article was on page 11 and was titled: 'Possessed cars leave villagers spooked'.)

846) EMI and early video games

In the IEEE Consumer Electronics Magazine – April 2014 there was an article on "The 2014 IEEE Edison Medal Recipient." It was a story about Dr. Ralph Baer, the father of video games, and it was a very entertaining and informative article. What "caught my eye" were a couple of paragraphs in the article that discussed EMC.

The first one was: "When Coleco Telestar, another first generation video game system, did not pass interference tests needed for the Federal Communications Commission approval, the company turned to Sanders and Ralph in hopes that Ralph's experience would be able to help them. Ralph found their solution within the week. Coleco received its Federal Communications Commission approval, and Coleco Telestar sold more than one million units in 1976."

The second one was: "Usually, we had only minor problems that could easily be fixed by moving wires around or with a solder joint here or there (we always brought tools). So there we were one day in the mid-1980s, demonstrating a prototype to a toy company in Chicago. We arrived, and as we had done many times in the past, started setting up and testing our demo units. Immediately, our prototype started playing music, and, mind you, we had not programmed it to do so, in fact the unit was turned off! As it turns out, the wires in our crude prototype were acting as an antenna, picking up a powerful local radio station – very embarrassing, but, we talked our way through it."

(Taken from "EMC Society History" by Daniel D. Hoolihan, Associate Editor, Chair of the EMC Society History Committee, published in the IEEE Electromagnetic Compatibility Magazine, Vol. 3 Quarter 2, 2014, page 30, http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?reload=true&punumber=5962381.)

847) Chaotic oscillations seen in a CMOS inverter with RF excitation

This study demonstrates the presence of chaotic oscillations in standard CMOS circuits. At radio-frequencies, ordinary digital circuits can show unexpected nonlinear responses. We examine a CMOS inverter coupled with electrostatic discharging (ESD) protection circuits, designed with 0.35 µm CMOS technology, for evidence of its chaotic oscillations. As the circuit is directly driven by a radio-frequency signal, the circuit enters a chaotic dynamic regime when the input frequency is higher than the maximum operating frequency of CMOS inverter. We observe an aperiodic signal, a broadband spectrum, and a complex spectrum.

…..many scientists and engineers exert great effort to tame these sensitive and often unpredictable behaviors occurring in their circuits. Examples of this phenomenon have been a subject of study in EMI community, and are often encountered when the electronics suffer from instability, which may have originated from both intentional and unintentional microwave sources.

The effect of microwave signals interfering with electronic systems is not an entirely new concern. Previous studies show that various physical mechanisms have caused instabilities when a circuit is excited by microwave signals. Many studies [12] [13] report rectifications of radio frequency (RF) signals by bipolar and field-effect transistors.

It is also reported that the nonlinear parasitic capacitance of electrostatic dischargings (ESDs) degrades a linearity performance [14]. A latch-up effect in semiconductor devices is presented due to EMI [15]. In addition to these low-order instabilities, some findings are reported about the high-order instabilities like spurious oscillations or unstable oscillations, which are unpredictable and difficult to understand [16] [17]. Highly nonlinear power amplifiers are often exposed to these phenomena, when they are driven under large RF signals [18].

(Two extracts from: "Chaotic Oscillations in a CMOS Inverter Coupled With ESD Protection Circuits Under Radio Wave Excitation" by Myunghwan Park, J.C. Rodgers and D.P. Lathrop, in IEEE Trans. EMC, Vol. 56, Iss. 3, June 2014, pages 530 – 538, ISSN: 0018-9375, http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6750052)

848) EMI at Saturn 1 launch in 1964

The Associated Press (AP) carried an article on January 29, 1964 relating to the delay in launching of the Saturn 1 rocket due to radio interference. The part of the AP dispatch which mentioned this is as follows: "The shot was delayed more than an hour by radio interference which affected a tracking-radar and the radio frequency on which the range safety officer would send a signal to destroy the rocket in case it strayed off course. The radar trouble was traced to a ship off shore which turned off its signal when it was advised, and the other interference was cleared up soon afterward.

When the trouble arose the countdown had reached 13 minutes, but one system aboard the rocket had to be turned off during the wait, so the count was set back to 25 minutes when it was resumed. The massive vehicle was intended to propel into orbit a 37,700 pound satellite, nearly three times as heavy as any previous man-made satellite."

(Taken from "Fifty Years Ago – May 1964 – Newsletter Number 33 – IEEE Professional Technical Group on Electromagnetic Compatibility (PTG-EMC)" by by Daniel D. Hoolihan, Associate Editor, Chair of the EMC Society History Committee, published in the IEEE Electromagnetic Compatibility Magazine, Vol. 3 Quarter 2, 2014, page 31, http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?reload=true&punumber=5962381.)

849) Problems with UHF tuners in 1964

An article from Electronics (February 21, 1964) stated the following: "FCC hopes makers of uhf tuners can come up with solutions to the problem of oscillator interference within a year. FCC's 500 microvolts per meter radiation limit for TV receivers clashed somewhat with the law requiring all sets being sold in interstate commerce to be equipped with uhf receivers after April 30, 1964.

Rather than revoke its rule, the FCC climbed out of the box by agreeing to continue the 1000 uV/m radiation limit until April 30, 1965. In the meantime, it is calling for research on tuner design and radiation suppression. The commission's determination to back strongly uhf/TV broadcasting was evident in a decision last week denying a permit for a vhf translator to serve Asheville, NC. FCC told Spartan Broadcasting Co. that it would look favorably on a uhf translator, or a second uhf station. Asheville already has one uhf station."

(Taken from "Fifty Years Ago – May 1964 – Newsletter Number 33 – IEEE Professional Technical Group on Electromagnetic Compatibility (PTG-EMC)" by by Daniel D. Hoolihan, Associate Editor, Chair of the EMC Society History Committee, published in the IEEE Electromagnetic Compatibility Magazine, Vol. 3 Quarter 2, 2014, page 31, http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?reload=true&punumber=5962381.)

850) FAA Orders Airlines to Replace Over 1,300 Cockpit Display Units

The U.S. Federal Aviation Administration (FAA) is ordering airlines to replace more than 1,300 display units in cockpits in Boeing Co. airplanes to avoid interference from Wi-Fi, cellular and electronic devices within the next five years. These displays were produced by Honeywell International Inc. It is crucial that these units function correctly because they are responsible for providing navigation, altitude and airspeed information to pilots and co-pilots.

"The display units were susceptible to interference from Wi-Fi frequencies. Independent tests conducted by the agency and Boeing both showed blanking on the screens when Wi-Fi devices were used near them. The displays are also susceptible to transmissions from mobile phones, weather radar and mobile satellite communications," the FAA said.

However; Steve Brecken, Honeywell spokesman, does not agree. He stated that no display screens were affected by Wi-Fi interference.

"The only known occurrence was during a developmental test conducted on the ground. We worked with Boeing and addressed any concerns in 2012 with new display hardware," he said.

It will cost more than 14 million dollars to replace all of the display units; each unit costs more than one thousand dollars.

(Taken from: www.interferencetechnology.com/faa-orders-airlines-replace-1300-expensive-display-units 10/23/2014, which was based on the Reuters article "U.S. orders airlines to replace cockpit displays on 1,300 Boeing airplanes" published on September 30, 2014 11:35 PM, reported by http://news.yahoo.com/u-orders-airlines-replace-cockpit-displays-1-300-020623861--sector.html.)

851) French Railways interfere with Large Hadron Collider

Banana Skin #844 reminds me of reading some time ago that the scientists at CERN had started to observe occasional 'blips' in the readings from their Large Hadron Collider's super-sensitive instrumentation. These did not yield any explanation when first investigated by their scientists, who had, however, observed that they generally occurred at about the same times each day, and that the traces were always of similar shape.

The media soon opened up with stories of 'little green men' in deep space trying to communicate or interfere with the experiments, without pausing to think that they could be of terrestrial origin in some way.

Came a weekend when a few of the scientists put in some overtime, and noticed that the blips were fewer in number, and sometimes occurred at times which did not correspond with the weekday ones.

One of them was probably, like me, a railway fan, so on a hunch called in at Geneva's main railway station to pick up a timetable for the (then) newly-introduced Paris-Geneva TGV service, and quickly discovered a correlation between the blips recorded at CERN and the TGV Paris-bound departure times.

The most difficult part, by far, of the subsequent investigation was finding a collaborative SNCF running inspector to arrange for one of the scientists to 'ride shotgun' in the TGV cabs to check the times when the trains left the 'classic' line and the driver applied 'full welly' for the high speed northbound run. The correlation proved to be exact. The instantaneous power surge on the 25kV overhead – for the fraction of a second it needed for the traction systems to start responding – did not remotely include enough "I2t" energy to trip any of SNCF's onboard or trackside protection kit.

Designing the filter to remove the traces was, of course, complete simplicity.

(Kindly sent in by Kevin Carleton-Reeves, who described himself as a "practising railfan" on 1st October 2014.)

(NOTE: it seems most likely that Kevin meant to say LEP instead of LHC, because a paper on interference from TGVs to the LEP is at: http://cds.cern.ch/record/309231/files/sl-96-036.pdf. This information was provided in March 2015 by Tom Sato of Japan.)

852) A fix for ESD problems with a USB3 device

Basically we found that the "ESD protected" data interface device in our product could get itself into a number of non-working states occasionally after ESD strikes – state machine or microcode in the device gets into a state where it is live but not communicating data (i.e. the control path still worked but the data path had stopped).

We found ways to detect these stall conditions and worked with the device manufacturer to determine how to restart the communications. So by polling for these conditions and correcting when required we can auto-recover.

(Kindly sent in by a designer who wishes to remain anonymous, in July 2014. Editor – in my training courses I always point out that ESD protected data devices, or the transient suppression devices marketed for protecting them against ESD, only protect from actual damage. The sales data for these devices doesn't make clear that other techniques will probably be needed a) to prevent false data from occurring, and b) to allow the functionality of the data interface to recover in a sufficiently short time to meet Performance Criterion B.)

853) Canadian Air Force helicopters suffer EMI

A Canadian military Sikorsky CH-148 Cyclone conducts test flights in Halifax harbour in 2010. (Image: Andrew Vaughan/Canadian Press) (Got picky!)

Electromagnetic interference concerns are hampering progress on a Canadian Air Force project.

According to The Canadian Press, the Canadian government has refused to accept four CH-148 Cyclone test helicopters currently parked at the Canadian Forces facility in Shearwater, N.S., on the basis that they are "non-compliant." Designed by Sikorsky Aircraft Corporation, the twin-engine CH-148 Cyclone helicopters are slated to replace the CH-124 Sea Kings, which have been in operation since 1963.

However, the Canadian news outlet reports, defense sources with intimate knowledge of the program have elaborated on the public report, saying that certain flight systems, including a computer that runs the engines, are not considered sufficiently shielded against powerful electromagnetic waves. The electromagnetic waves could potentially scramble the digital instruments and shut down the engines.

A Canadian military Sikorsky CH-148 Cyclone conducts test flights in Halifax harbour in 2010. (Image: Andrew Vaughan/Canadian Press)

Earlier this year, the directorate of airworthiness at the Department of National Defence and the Canadian Armed Forces cited electromagnetic compatibility, electromagnetic vulnerability and electromagnetic interference concerns in its decision to impose flight restrictions on the CH-148 Cyclone helicopters.

"Each of them [the concerns] are potential show-stoppers," a defense source, who asked for anonymity, told The Canadian Press.

"The vulnerability depends on the frequency and the strength of the signal. You have the potential of losing your instruments and not knowing where you are, and having to take visual cues from outside your aircraft to get down safely."

Air Force engineers and government officials are increasingly skeptical regarding whether or not the shielding problem can be sufficiently remedied in a reasonable amount of time. Initially scheduled to be ready for service in 2008, only a few Cyclone helicopters have thus far been delivered for testing. The project is five years behind schedule and over-budget.

"The aircraft was not designed from the ground up with this kind of shielding in mind," the defense source told The Canadian Press. "Military aircraft, the skin of military aircraft, [is] sometimes embedded with a fine copper screen or mesh to prevent the intrusion of electromagnetic interference." The CH-148 Cyclone helicopters, however, are based on a less-rugged civilian design.

Sikorsky declined to comment on the technical concerns on the basis that the contract forbids the company from publicly discussing certain aspects of the program. Public Works, who manages the contract on behalf of National Defence, similarly declined to offer specific details, saying only that they are working on the problem.

"At some point, someone should say enough is enough," defense expert Michael Byers, of the University of British Columbia, said. Byers documented the Conservative government's struggles with the Cyclones in a report earlier this year. "The question is, when are they going to stop messing around and deliver a highly functioning maritime helicopter for the men and women of the Canadian Forces?"

John Dawson adds: "Several years ago we tested several Canadian helicopters for compatibility with our US Navy shipboard EM environments. The lesson learned, you get what you specify. If EMC is not integrated into the early design, it's going to fail. Fixing after the fact, is always cost prohibitive. It's always cheaper to do it right the first time, then to pay over and over again to build band aids."

(Taken from www.interferencetechnology.com/canadian-air-force-helicopters-beset-with-emi-woes by Aliza Becker, 09/19/2013. More information at: www.cbc.ca/news/politics/new-cyclone-choppers-beset-with-technical-snags-1.1700828. The comment by John Dawson was timed at 3:03 pm on 09/19/2013.)

854) PCs' EM emissions can carry information that can be picked up nearby

To the best of our knowledge, this paper is the first to show that EM information leakage from modern laptops and desktops (with no peripherals attached) is indeed possible and is relatively easy to achieve.

The experiments were performed on three laptop systems and one desktop system with different processors (Intel Centrino, Core 2, Core i7, and AMD Turion), and show that both active (program deliberately tries to cause emanations at a particular frequency) and passive (emanations at different frequencies happen as a result of system activity) EM side-channel attacks are possible on all the systems we tested.

Furthermore, this paper showed that EM information leakage can reliably be received at distances that vary from tens of centimeters to several meters including the signals that have propagated through cubicle or structural walls.

Finally, this paper showed how activity levels and data values used in accessing different parts of the memory subsystem (off-chip memory and each level of on-chip caches) affect the transmission distance.

(Taken from: "Experimental Demonstration of Electromagnetic Information Leakage From Modern Processor-Memory Systems", by Alenka Zajić, Senior Member, IEEE, and Milos Prvulovic, Senior Member, IEEE, in IEEE Transactions on EMC, Vol. 56, No. 4, August 2014 pp885-893.)

855) ATC (Automatic Train Control) abnormal behaviour in mining areas due to EMI

1.7 SS2: Spot Signalling Systems: Abnormal Behaviour in Mining Areas

1.7.1. Name: ATC (Automatic Train Control) abnormal behaviour in mining areas

1.7.2. Date: 2003

1.7.3. Participant/Customer/Involved body: LTU and MTAB (mining train operator for LKAB mines)

1.7.4. Nature of the EMI: The ATC transmitter is disturbed by a 'heap of iron balls' underneath the locomotive. The locomotive stops, and the ATC has to be switched off in the mining area.

Figure 18 The ATC transmitter disturbed by a 'heap of iron balls' underneath the locomotive.

1.7.5. How did the interested party identify the EMI? The locomotive stopped where it crossed over a heap of iron (composed of pellets that fall down in the loading process).

1.7.6. How did you, the participant, deal with the EMI? The ATC radio was switched off when the train approaches a heap and switched on again when the train has passed.

1.7.7. What was the main source of the EMI? The heap of ore was acting as EM mirror and reflected EM waves were disturbing the transceiver of the system.

1.7.8. What steps were taken to prevent repeat occurrence? The ATC radio is switched off as a routine in these mining areas due to the frequency of appearance of these heaps.

1.7.9. Reasons why there may have been an issue with EMI: In high enough numbers, the small balls of Iron make up a perfect EM mirror where all EM waves are reflected. Since the ATC transceiver is less than one meter away from this EM mirror the disturbances are very high.

1.7.10. Likelihood of repeat occurrence or similar issue after participant involvement: The issue is not solved and the routine of switch off is still active. The phenomenon described in this case study is easily applicable to any other spot signalling system which has to transmit a signal to awake the balise or the emitting cable. Some of the cab signalling systems used in European lines considered for Interoperability have been listed in the previous case study (SS1).

(A small extract from the 36-page document that is TREND Report D2.1 "Collection of EMI Experiences and establishment of qualitative relationships", 20 December 2011, from: www.trend-eu.org/deliverables/resultsdeliverables.html. TREND is "Test of Rolling Stock Electromagnetic Compatibility for Cross-Domain Interoperability".)

856) EMI could affect bird migrations

The internal magnetic compasses of migratory birds can be disrupted by weak, man-made electromagnetic interference, according to a new study. The unexpected effect was seen in European robins, which were unable to orient themselves in the presence of broadband, radio-frequency noise believed to be caused by AM radio and electronic signals.

Given previous theories that robins might be affected by radio-frequency magnetic fields, the European researchers experimented with reducing local electromagnetic noise by screening the bird's huts with electrified and grounded aluminium plates. This shielding reduced the interference by two orders of magnitude, while leaving the static geomagnetic field unaffected, and this restored the bird's ability to orient themselves. (Nature 10.1038/nature13290)

(Kindly sent in by Richard Marshall, who spotted "Noise could set European robin adrift", in "Frontiers", Physics World, June 2014, page 4, www.physicsworld.com.)

857) Increasing need for reliable industrial comm's to have RFI/EMI protection

The increasing need for reliable communications in factories and plants means that more and more industrial electronic equipment may require built-in radio frequency interference (RFI) immunity. At the same time, this equipment's susceptibility to the electromagnetic interference (EMI) effects of inductive load switching relays and noise induced by heavy operating equipment must be considered.

It is, however, possible that you will not know you need RFI/EMI protection until somebody keys up a radio transmitter near your device or mounts it in a noisy electrical environment and the output readings become erroneous.

(Taken from "Making the right choice", by Amplicon, in Instrumentation magazine, March 2015, pp 17-18, www.connectingindustry.com/instrumentation.)

858) Lightning strikes cause downtime for petroleum refinery

Control Engineering Europe looks at the journey taken by Tüpras Kirikkale petroleum refinery to ensure its plant is better protected from downtime due to lightning stikes in the future.

Tüpras Kirikkale petroleum refinery was established in 1986. One of the plants within the refinery contains a diesel desulpherisation (DHP) and continuous catalyst regeneration (CCR) unit.

Since commissioning, in 2007, this plant has suffered a series of electrical trips, caused by lighting strikes in the area.

To help overcome the problem the company asked experts from Yokogawa Italy to help to identify the root cause of the plant shutdowns. Following a site survey in 2013, Yokogawa collected information and measurement data to prepare a report for the company.

The report concluded that the safety system had performed a safety action because the same event had occurred in in many areas of the plant – this consisted of an overvoltage on an input or output channel coming from external devices or cabling, due to lightning strikes.

Analysis of the data did not identify whether the channel overvoltage was caused by equipment installed internally in the system or by marshalling cabinets. This kind of overvoltage is considered to be a major failure of the safety input/output loop, causing the system to drive the plant in a safe conditon (shutdown on emergency).

(Taken from "Eliminating downtime caused by lightning strikes", in Control Engineering Europe, 17 February 2015,www.controlengeurope.com/article/90631/Eliminating-downtime-caused-by-lightning-strikes.aspx.)

859) Industrial control panels more susceptible to Power Quality issues

In view of the progress of electronic development of PLCs, sensors, and the like, the electronic components (that are used to assemble industrial control panels – Editor) become more sensitive to voltage dips and interruptions.

(Taken from "Electronic circuit breakers protect 24V dc circuits in industrial control panels", by Cristoph Wesner, Dipl.-Ing. (FH), in Control Engineering Europe, April 25, page 18,

www.controleng.com/single-article/electronic-circuit-breakers-protect-24-v-dc-circuits-in-industrial-control-panels/77bcbeb9e83743ad6564dd6bab86e814.html.)

860) Nearly all PhotoVoltaic inverters assessed were EMC non-compliant

- The majority of EUT - 32 (58 %) - were of EU / EFTA origin.
- Approximately a third (33 %) of the EUT met the disturbance emissions compliance tests.
- Approximately a third (38 %) of the EUT met the administrative requirements (as assessed).
- All but one assessed EUT (54) were CE marked (2 were incorrectly formatted).
- A quarter (25%) of DoC was not provided, and 75 % of the DoC provided were correct.
- Nearly all (91 %) of the EUT were assessed as overall non-compliant.
- Study of emissions below 150 kHz (optional): approximately a third of the EUT (38%) were found compliant to EN 55011 Table 8 limits at mains terminals in the frequency range 9 kHz-150 kHz.
- Study of DC side (optional): approximately a half of the EUT (43%) were found compliant to EN 61000-6-3 emission requirements to the DC power port.
- From the results obtained of the solar panel inverters under test, the majority did not meet the harmonised standards that would provide a presumption of conformity with the EMCD.
- The EUT represented a large sample of the products available on the market and it is clear that much remains to be done by manufacturers in terms of compliance.

(Taken from page 12 of "Conclusions, EMC Administrative Co-operation Working Group, Report on the 6th EMC Market Surveillance Campaign 2014, SOLAR PANEL INVERTERS (Grid-connected PV inverters and optimisers intended to be used by consumers). This document may be downloaded from the "Member's Area" at www.emctla.com, or else Google "6th EMC Market Surveillance Campaign 2014")

861) Variability of ESD test results

The immunity to ESD of present-day electronic components and devices has further decreased due to the high sensitivity of ICs.

Electronic devices can be exposed to electrostatic discharge (ESD). The discharge process generates rapid electric and magnetic processes that can impair the function of the electronic devices. Devices are tested for their immunity to ESD using special ESD generators and test setups (EN 61000-4-2).

The effort and expense for developers to achieve ESD immunity in compliance with EN 61000-4-2 has steadily risen over recent years. The causes for this increased effort and expense are firstly the technology-related increase in sensitivity of ICs. Secondly, position changes, tilting and turning of the ESD gun yields different measurement results during ESD testing. That means even device or component tests performed with the same ESD gun will not be identical. Thirdly, it has been discovered that different types of ESD generators ("ESD guns") create different scattering in the test results. Device tests performed with different ESD generators are therefore also not always comparable.

A MORE DETAILED DESCRIPTION OF THE PROBLEM

IC sensitivity to interference is increasing. One reason for this increased sensitivity is that the structural width of ICs is shrinking. ASICs and microcontrollers are currently approaching 10 nm. Shrinking structural geometries allows higher switch speeds of the transistor cells while also reducing supply voltage. This necessarily increases IC sensitivity to interference. Increased switch speed in ICs gives rise to a greater possibility of interference from shorter disturbance pulses (less than or equal to 1 ns). Several years ago, these relatively short disturbance pulses were not an issue; they were not "seen" by the ICs.

CHANGES IN THE LENGTH OF ESD GUNS (ESD GENERATORS)

The ESD generator is typically in the shape of a gun with a metal tip. When testing "contact discharge", this metal tip is touched onto metallic parts of the test setup in order to trigger the test pulse. The current pulse introduced is relevant to the interference. It is defined in the standard EN 61004-2. Its curve shape parameters should define the interference effect during the test procedure.

In practice, the ESD gun does not necessarily obey the curve shape parameters. Interference phenomena occur that are difficult to explain. For example, certain EUT may only experience interference when the right side of the gun is facing it, while all other sides cause no interference. This would be explained by fields emanating from the gun housing that act on the EUT.

ESD guns cause rapid transient electric and magnetic fields. These fields emanate from the housing of the ESD gun and can act on the EUT during testing. The ICs of the electronic circuit will therefore react with failures according to their sensitivity. The sensitivity of ICs depends on the manufacturer and technology. The faster an IC is, the shorter disturbance pulses it can see and convert into errors. As the speed of an IC increases, so does its sensitivity to pulsed fields.

The internal structural components of ESD guns create these fields. Electric fields are generated by the switching of the high voltage switch. Magnetic fields are generated by the resulting recharge currents. (Figure 1a and Figure 1b)

The electric pulse fields couple capacitively from the gun into signal lines, test points, pads, IC pins and internally into the IC. The coupling capacity is in the fF range. Determinative of the gun's interference effect is the field strength E as well as its change over time dE/dt.

The magnetic field induces voltage in conductor loops in the electronics. These loops can exist as conductive traces on the component or inside the IC. Determinative of the interference effect is flux φ or dφ/dt.

ESD guns contain all kinds of internal conductor systems, switches and components that can generate E or H fields. The high voltage switch of the ESD gun can switch in the range of 100 ps. The tester can hold the gun tip to the EUT at different distances and orientations. The gun housing can in some cases rest against the EUT. The gun is deliberately turned and tilted. This brings different field generating parts of the gun closer to the electronics.

It is known from practice that ESD guns have different interfering effects depending on their type and position.

(Taken from "EMC Properties of ESD Generators", by Gunter Langer, in the In Compliance 2014 Annual Guide, pp 172-176, www.incompliancemag.com.)

862) Not all RJ45 cables and connectors have equal noise immunity

Not all cables with RJ-45 connectors meet the same specification. The table below compares cabling schemes, and reveals that the IMI connector achieves the highest noise immunity. Industrial cables with RJ-45 cables may be OK for machines, but commercial off-the shelf RJ-45 cables should not be considered for a machine to be reliable.

	Cable radiation noise immunity		**Noise Immunity Conclusion**
IMI STP 50m	*+1800 V*	*-1800 V*	*Best*
RJ-45 STP Industrial Grade 50m	*+1400 V*	*-1400 V*	*Good*
RJ-45 STP COTS 50m	*+200 V*	*-100 V*	*Very Poor*
RJ-45 UTP COTS 50m	+100 V	-100 V	Very Poor

Noise immunity comparison of various Ethernet cables with various connectors.

(Taken from "Symptoms of unreliable machine control systems", by Derek Lee, in the Industrial Ethernet book, October 2014, www.iebmedia.com/index.php?id=10429&parentid=63&themeid=255&hft=84&showdetail=true&bb=1)

863) RFI prevents smoke detectors from alarming

Two separate operating units of the United Technologies Corporation of Hartford, CT have recalled a combined total of over 140,000 smoke detectors manufactured in China.

According to a press release issued by the U.S. Consumer Product Safety Commission (CPSC), radio frequency interference (RFI) can cause the smoke detectors to fail to alert consumers of a fire. There have been no reports of incidents or injuries related to the smoke detectors, but the company has issued the product recall to prevent the risk of future incidents.

The recall involves Edwards-branded and Interlogix-branded units that have been hardwired into security systems. They were sold through alarm system, security system and electrical equipment contractors, dealers and installers for use in fire alarm systems installed in commercial buildings, hotels, apartments, schools, dormitories and homes from March 2013 through February 2014.

image 2 of 3 Recalled ESL/Interlogix smoke detector, 500 series

image 1 of 3 Recalled ESL/Interlogix smoke detector, 400 series

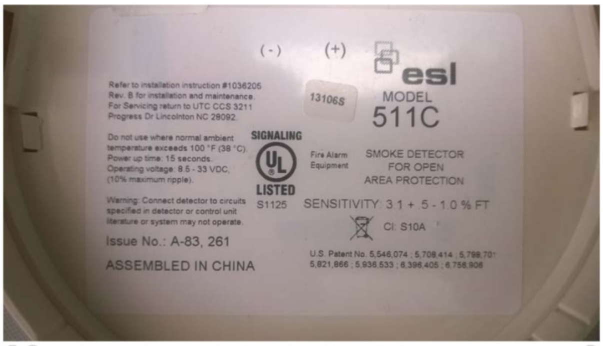

image 3 of 3 ESL, the date code and model are printed on a label on the back of the detector's cover.

UNITED STATES CONSUMER PRODUCT SAFETY COMMISSION

(Taken from *"Recalled Smoke Detectors Fail to Alert", in the "News" section, on page 10 of In Compliance magazine, October 2014, http://www.incompliancemag.com/DigEd/icm1410/. For the original CPSC recall notice, visit www.cpsc.gov/en/Recalls/2014/ESL-Interlogix-Hard-Wired-Smoke-Alarms-Recalled/.*

The Editor comments – US magazines are always keen to mention when products recalled for safety reasons were not made in the USA. However, in this case it is likely that the RFI problem was caused by inadequate design (in a country that is not mentioned) or inadequate assembly. From time to time it is noticed that offshore electronic assemblers sometimes omit what they think are non-essential components, such as EMI filters, to save cost. Whether the design or the assembly was at fault, it is the responsibility of the company that markets the products under their own brand names to apply adequate Quality Control to ensure their customers are safe enough. And in this case, that company is not based in China.)

864) Ravens overcame headset EMI issues in Miami

The Ravens were unable to communicate to quarterback Joe Flacco's helmet Sunday.

Joe Flacco got in an extra workout running back-and-forth to the sidelines between plays Sunday afternoon.

The Ravens quarterback had to consistently jog over to the sidelines to get the play calls from Offensive Coordinator Gary Kubiak because of communication issues from the sideline to the transmitter in his helmet.

All quarterbacks wear a helmet with a radio signal transmitter inside to allow them to hear play calls from the sideline or the coach's box. But that line of communication was halted because of interference with the frequency.

"It was crackling the whole time," Head Coach John Harbaugh said. "We couldn't get our plays in and we couldn't hear from the press box. Finally we had Gary on a wire in the second half, which made his communication better, but it was really no better back to Joe."

To offset the communication barrier, Flacco had to run over to the sidelines to talk with Kubiak or the Ravens would send in the play call by changing personnel on the field.

"We were old-schooling it," Harbaugh said. "We were running plays out there and shuttling plays with players back and forth. It was a challenge."

The exact cause of the issue was unknown, but Harbaugh said it's been a common problem during Baltimore's recent trips to Miami.

"We always have trouble in Miami for some reason," Harbaugh said. "We always have trouble down there with interference, radio stations and whatever is going on down there. Hopefully that will get fixed someday, but it's been going on for years there. It must not be something that can be dealt with."

(Posted Dec 8, 2014 by Garrett Downing,Staff Writer for BaltimoreRavens.com: www.baltimoreravens.com/news/article-1/Ravens-Overcame-Headset-Issues-In-Miami/fbae31a0-f448-43de-8b5e-27e4d395683f#commentSystem. Also posted on 12/17/2014 as: www.interferencetechnology.com/radio-interference-causes-headset-issues-during-football-sunday)

865) EMI is a major issue for broadcast radio and TV

The 66th IEEE Broadcast Technology Society Fall Symposium got underway Wednesday in Hartford, Conn., with the group's President Bill Hayes welcoming some 190 attendees, which included 40 students and their professors from Quinnipiac University and the University of Hartford.

Increasing RF noise pollution is a concern to almost everyone now, and the symposium program reflected this with presentations on manmade noise from Wisconsin Public Radio's Director of Engineering and Operations Steve Johnston, and Tom King, president of Kintronic Labs.

Johnston described measurements of indoor and outdoor RF noise levels and how such interference is creating problems that are not just limited to the AM broadcast band.

"The growing level of noise is hurting otherwise receivable AM, FM and TV signals," said Johnston. "Streaming is not really the solution, as this is not always available in rural areas."

King provided an update about efforts by a number of groups to help curb interference, noting that more and more spectrum is being impacted due to the increasingly higher operating frequencies used in switching power supplies. He concluded by stating that "the FCC needs to take action to remediate this noise floor situation."

ARRL PAYS A VISIT

Tom Gallagher, CEO at the American Radio Relay League, journeyed from the amateur radio support organization's base of operations in nearby Newington, Conn., to deliver a luncheon address about the ARRL's history, services and ongoing projects, which include efforts to help clean up the RF interference problem.

Manmade radio frequency noise remained a topic as afternoon sessions got under way, with the first presentation from Ed Hare, ARRL's test lab manager, who described ongoing efforts to help identify and remediate noise problems. He noted that powerline companies are big offenders and aren't always cooperative when confronted with evidence of the problems their distribution systems cause.

David Layer, senior director of advanced engineering at the NAB, followed Hare with a presentation on "noise" of a slightly different nature — co-channel interference to experimental all-digital AM broadcasting operations.

*(From "*2016 IEEE Broadcast Symposium Curtain Rises in Hartford*" by James E. O'Neal, www.radioworld.com/article/2016-ieee-broadcast-symposium-curtain-rises-in-hartford/279816#sthash.8xGGbwmr.dpuf on 10.12.2016.)*

866) EM noise evaluation of 3rd-party DC-DC converters

More of my clients are starting to use small third-party DC-DC converters to provide the multitude of voltages required for today's processor and DDR RAM ICs. While these are convenient to drop onto a circuit board, they can be quite a source of radiated and conducted emissions – especially those that switch in the MHz range.

I recently published an article on how these converter circuits can generate harmonic noise all the way up to 1 GHz, and above, severely compromising RF receiver sensitivity in the wireless telephone bands [1]. Kevin Slattery and Harry Skinner called this "Platform Interference", in their book, Platform Interference in Wireless Systems – Models, Measurements, and Mitigation [2].

One example of this type of "drop-in" DC-DC converter is manufactured by Murata and we'll use their model UWE-24/3-Q12, which is an "Eighth Brick" power supply that can take 9 to 36V and convert it to 24V at 3A (Figure 1). My client was using three of these converters on a product and was measuring a high level of radiated emissions, as well as observing broadband noise throughout his system all the way through 150 MHz.

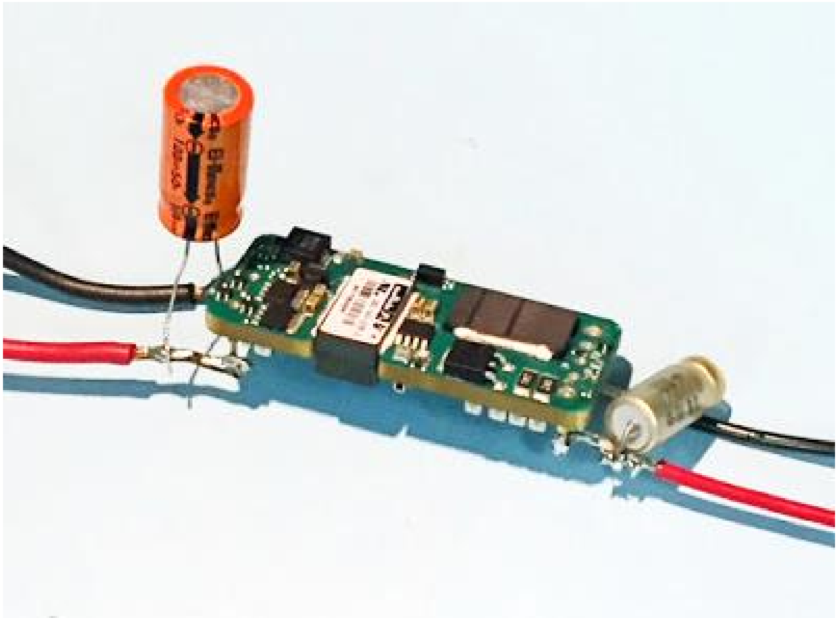

Figure 1 – The Murata UWE-24/3-Q12 DC-DC converter.

The manufacturer recommends specific capacitors on the input and output, and I've tack-soldered these on as shown.

If you read the manufacturer's specification sheets, you'll generally find that to "pass EMI" will require "additional filtering", and this converter is no different. In this case, the additional filtering required to meet EMI limits was not described. I decided to bring one of these back to the lab and try some experiments to attempt to quiet the EMI.

To do this required some instrumentation. I used a Siglent Technologies SPD3303C three output power supply, a Tekbox Technologies TBOH01 5uH LISN, A Tekbox Self-Powered Active Load, and a Siglent Technologies SSA3032X spectrum analyzer. All this gear is available from the U.S. distributor, Saelig Electronics [3]. The active load was really handy, because I could dial in the exact load current I wanted…in this case 0.5 amps, to avoid cooling issues. I connected a couple of Fluke DMMs to monitor the output voltage and current (Figure 2). The spectrum analyzer picked off the conducted emissions via the LISN.

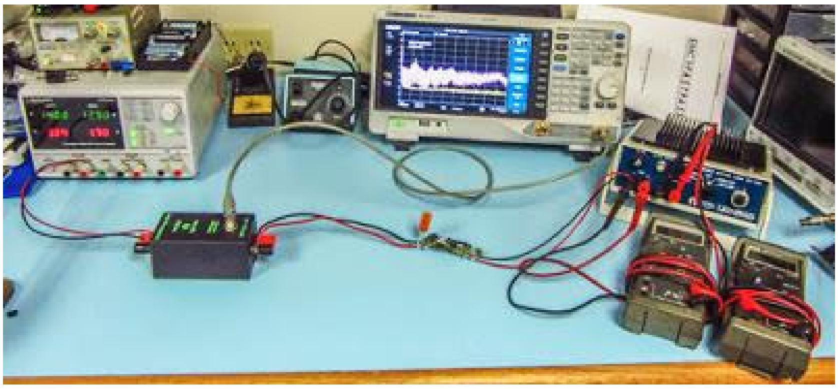

Figure 2 – The test setup for evaluating the conducted emissions from the Murata DC-DC converter.

After trying some inductors and common-mode chokes I had on hand, I determined that simply placing a 100µH inductor in series with the input terminal was enough to quiet the emissions rather drastically (Figure 3).

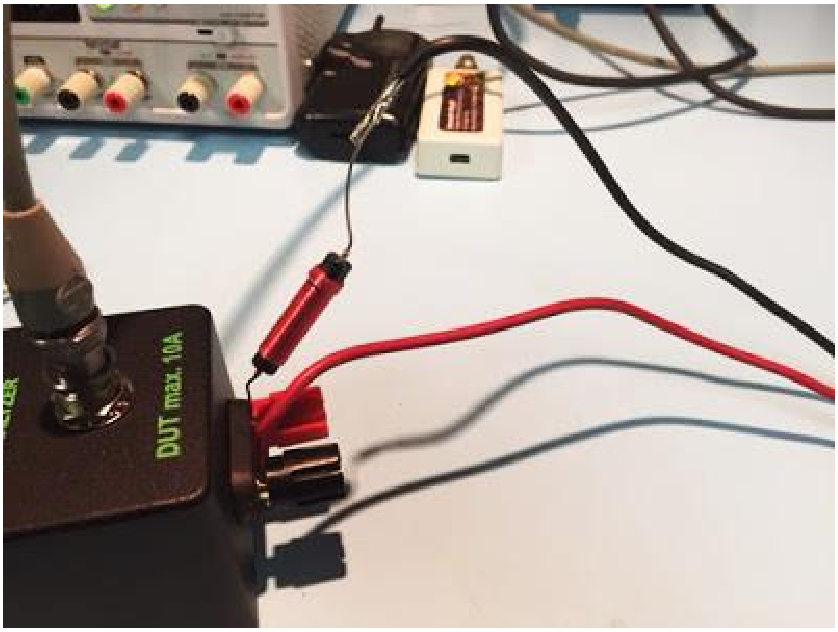

Figure 3 – A 100 µH inductor was all that was required to dramatically reduce the conducted emissions.

Figure 4 shows the result. The yellow trace was the ambient (baseline) signal level. The red trace was unfiltered (no inductor) and the blue trace was with the inductor added in series with the input voltage to the converter.

The addition of a single inductor nearly reduced the conducted emissions down to the noise floor of the measurement.

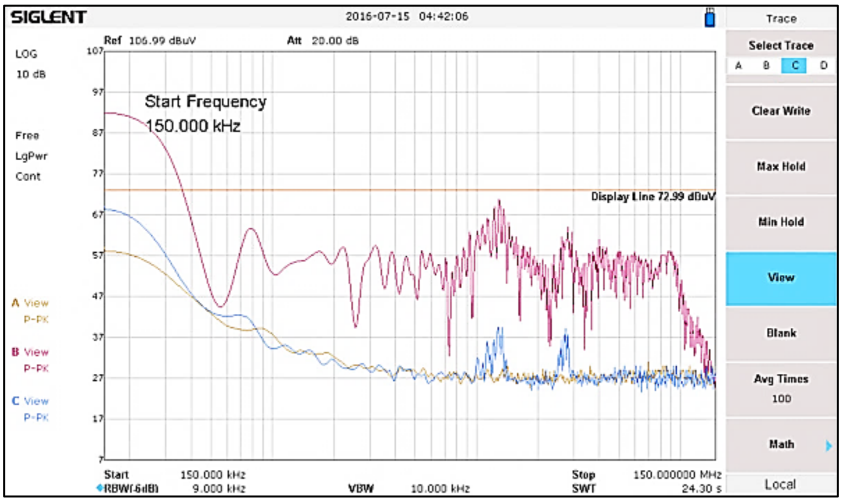

Figure 4 – The results with the 100 uH inductor installed (blue trace) over 150 kHz to 150 MHz. The red trace is the unfiltered noise and the yellow trace was the ambient baseline noise. The display line is the approximate emissions limit.

Conclusions:

Many EMI tests may be conducted right at the bench top. Evaluating various vendor products, such as DC-DC power supply converters, is always wise, prior to committing to a PC board design.

It's also wise to verify EMI performance as well as reading the "fine print" within the product specification sheet. Very often, claimed EMI performance will require additional components.

References:

[1] Wyatt, Platform Interference, http://www.edn.com/electronics-blogs/the-emc-blog/4441086/Platform-interference

[2] Slattery and Skinner, Platform Interference in Wireless Systems – Models, Measurements, and Mitigation,www.amazon.com/Platform-Interference-Wireless-Systems-measurement/dp/0323281451/ref=sr_1_2?ie=UTF8&qid=1450492921&sr=8-2&keywords=Platform+interference

[3] Saelig Electronics, www.saelig.com

*(From the article "*DC-DC Converter Noise Evaluation*" by Kenneth Wyatt, of Wyatt Technical Services LLC, published in Interference Technology Magazine's EMC ZONE on August 31, 2016, www.emc-zone.com/2016/08/dc-dc-converter-noise-evaluation.html. EMC ZONE is an avenue for discussion on the current issues affecting today's engineers working in the EMC industry. Ken is an excellent EMC engineer with huge experience, and these days specialises in showing the rest of us how to avoid/solve EMC problems quickly and easily on our own test benches using low-cost test equipment.)*

867) Illegal and dangerous installation of ferrite beads on US power distribution poles

The chief engineer at our local power cooperative called me yesterday. He asked if I could come to their local office around 9:00AM this morning. He promised me it would be interesting and well worth my time.

We drove toward the other side of XXXXX County and he asked how "plugged in" I am with the local radio community. I told him that I am a loner by nature and while I had been in a local ham club twenty years ago, these days I only participate in the severe weather nets. I mentioned I that there are about 20 hams and SWL within a 30 mile radius of my home that are what I consider serious HF operators.

He laughed as we pulled next to a substation and he led me over to a power pole and asked if I had ever seen anything like the "thing" he pointed to. I said "No, but I bet it is a string of ferrite beads in a PVC shell." He grunted, walked back to his truck and brought out a work light (a torch for those on the other side of the big pond) with a magnet on the bottom. He placed the magnet against the plastic shell and surprise surprise, it stayed in place.

We walked back to this truck and I asked if I could use his laptop with a "cell phone" modem to do some digging. He moved it over, it is on a very nice mount that I hope to copy for my radio desk, and I quickly found the clowns selling the "thing", a company called XXXXXX, and downloaded the information on it. I explained its intended purpose and noted that there is a MW station and the Non Directional Beacon for the XXXX airport within a mile or so of where we were, so it may well be solving someone's receive intermodulation problems, but that it defeated the ground wire's function to allow fast transients to pass through the wire to the "ground'.

Power poles are buried on average 6 feet deep and have a spiral of copper wire at the bottom that runs up the side of the pole to provide a lighting "protection". It works better than I would have thought, but is less than ideal. He mentioned that some of his customers demand much better grounding at the step-down transformer to their service drops.

The chief engineer loved this quote from the “thing's” downloaded information; "*Once you have determined which poles are causing problems, you develop a plan of action. The first thing to do is to contact the power company to explain what the problem is. They will not allow you to cut the pole ground wires to solve your problem, but if you can guarantee continuity of the ground wires with the same gauge and type of wire, they usually allow you to fix your problem*". His response was "Bull Shit! We never allow anyone to tamper with protective grounds."

It is a felony in this State to "mess" with the power distribution system; and cable and telephone are also protected. As we walked the road we found 5 more poles with these 'things' on them. He radioed back to Dispatch to send a couple of work crews to restore the grounds to the correct state. I asked if he wanted me to see if I could find out who placed them there, and he told me no. The devices would be turned over to their legal counsel and if they found out who installed them, they would be forced to press charges. He told me he didn't enjoy the thought of some poor clown getting a 5 to 10 year jail sentence for something so insanely stupid. At my suggestion he had the staff back at Dispatch make a bunch of laminated warning signs to inform "whoever" where his devices had gone, that he had violated the law and if he really wanted to face prosection, to drop by the power cooperative and talk it over.

XXXXX's web page does not give a price, but given the rest of the snake oil they are selling, I suspect the guy spent a bundle on these “things”. I do not know how many were found and replaced. At this point I am just shaking my head in disbelief over the insanity out there. The sad part is that the Chief Engineer told me if the guy had contacted them, they have several tricks they can use to reduce the problem he was trying to correct, and it would have been done at the power cooperative's expense.

On the way back to the office I asked him about the effectiveness of their decentralized grounding system and he told me that it works better then most non-power engineers would believe. Even direct strikes generally only trip a few transformer breakers or blow a few fuses. About 1 in 500 strikes causes a transformer failure. He admitted it might be higher because a transformer might be damaged and start to arc inside and run that way for days or months before it fails.

He told me they have contracted with a company to provide them with near real time data on strike locations, along with the polarity and an estimate of the intensity. He admitted that given the nature of a lighting bolt, the actual ground strike point may be several hundred to thousand feet in error. They are starting to log strike locations and look for delayed failure patterns. He said that in the event of a direct hit, the ferrite beads in the “things” we had found on the poles would explode and so could present a safety hazard, but the risk to the system came from nearly invisible streamers that never complete the connection with a cloud, so the grounding system is used a lot more than one would think.

I was rather surprised to find out that cold weather is much rougher on transformers and substations then hot weather and the first real cold snap will reveal a lot of transformers that are failing, but either no one has complained about the arc, or the arc isn't producing much RFI.

He told me it was funny that he has seen transformers with major insulation failure that were dissipating several kW in heat from the internal arc(s) that were as RF quiet as a good transformer, and that he has seen those with only a few hundred mA leakage that are RFI nightmares.

Being in the RFI business, or perhaps I should say the "fighting RFI business", I thought you might enjoy this odd anecdote. And you think we resort to extreme measures to reduce the local RFI…. At least life is interesting!

(From a private discussion with the Editor in December 2009. Because of the legal implications, all the locations and names have been redacted.)

868) Radio Interference Caused by 1967 Solar Storm Nearly Started Nuclear War

(August 9, 2016) Business Insider reported that a colossal solar burst caused radio interference in 1967 that almost started a nuclear war.

The “Great [Solar] Storm” of May 1967 caused widespread radio communications blackouts, and was seen as potential jamming from Soviet Russia. The Air Weather Service (AWS) — a relatively new branch of the Air Force — had warned military leadership about the possibility of a solar storm, but US commanders believed the Soviet forces were jamming NORADsystems designed to detect threatening planes and missiles and radio jamming, at the time, was interpreted as an act of war.

As the Strategic Air Command (SAC) warmed up the engines of bombers and taxied toward the runway, the decision to go airborne may have been kicked all the way up to the highest levels of government, possibly involving President Lyndon B. Johnson.

“Just in time, military space weather forecasters conveyed information about the solar storm’s potential to disrupt radar and radio communications,” according to a press release from the American Geophysical Union. “The planes remained on the ground and the U.S. avoided a potential nuclear weapon exchange with the Soviet Union.”

(From a report with the same title published in Interference Technology magazine on 31st August 2016: www.interferencetechnology.com/radio-interference-caused-1967-solar-storm-nearly-started-nuclear-war/?utm_source=itnewsletter&utm_medium=email&utm_campaign=20160901. For the original Business Insider article “A giant solar storm nearly triggered a nuclear war in 1967*” visit http://uk.businessinsider.com/cold-war-geomagnetic-storm-radio-disruption-2016-8?r=US&IR=T.*

869) Conducted EMI can cause misreading of electronic electricity meters.

Conducted electromagnetic interference can cause misreading of static electronic energy meters. This was already observed in the past, but only for cases with lower energy reading. In one actual case the cause of this misreading is the interfering currents caused by active infeed converters for renewable energy. In this paper it is shown that also higher readings are possible.

Electromagnetic interference tests have been introduced so that static meters will be immune against this type of interference. The static energy meters are used for billings and if a customer files a complaint the meter can be calibrated. However, this is done using ideal sinusoidal voltages and currents, while in our current living environment the currents deviate substantially due to the non-linear loads of modern equipment.

Controlled experiments performed on static energy meters confirm that they can present still faulty, and substantially higher, readings. The main cause of interference appears to be the current sensor.

Meters with a Rogowski coil current sensor showed a positive deviation of 276%, or an increased reading of 376%, using a controlled power supply with undistorted voltage and defined impedance, compared to the reading of a conventional electromechanical meter based on the Ferraris principle. Meters with a Hall sensor showed a deviation of registered energy of -46%, or a decrease in energy reading to 54%.

Using the mains supply in the laboratory, from 9 static meters 5 showed positive deviations of up to 582%, which is a higher energy reading of 682%, and 2 showed deviations of around -30%, equivalent to a reading of 68%.

(The Conclusions of the paper “Static Energy Meter Errors Caused by Conducted Electromagnetic Interference”, by Frank Leferink, Cees Keyer, and Anton Melentjev, in the 2016 IEEE Electromagnetic Compatibility Magazine – Volume 5 – Quarter 4, pages 49-55, http://ieeexplore.ieee.org/xpl/tocresult.jsp?isnumber=7866217. Kindly sent in by John Woodgate.)

870) Filament light bulbs have three ways of emitting EM noise

……….a short note summarising the findings of 1953 Wireless World correspondence on lamps as sources of interference with television. The main point put on record was that gas-filled lamps may interfere when they are so near the end of their life that a microscopic break occurs in the filament, across which an arc is produced, but vacuum lamps can radiate interference throughout their life. No explanation was offered of how vacuum lamps managed to perform this remarkable but objectionable feat, so I have looked into the matter to see if it could be explained.

(Taken from “Vacuum Lamp Interference” by “Cathode Ray”, in Wireless World, May 1954, pages 245-248, available from the truly remarkable website http://www.americanradiohistory.com, more specifically from http://www.americanradiohistory.com/Archive-Wireless-World/50s/Wireless-World-

1954-05.pdf. Cathode Ray goes on to describe Barkhausen-Kurz oscillations, and how they can occur in vacuum lamps.)

(John Woodgate writes (Feb 2017): I am astonished (;-) that the committee, and indeed the lighting industry, is not aware that (until yesterday, strange coincidence!), this effect was described on my web site. See the attached file *(the Wireless World article above – Ed.)*, and note the date of original publication, May 1954. Note for enchantingly young people: “Cathode Ray” was Marcus G Scroggie, a most trustworthy engineer and very well-known tutor.)

(See also EMI Story number 159, which describes how roughly 1% of “coiled coil” gas-filled filament light bulbs are significant sources of emissions at VHF due to “monode” oscillation. This brings the total number of ways in which filament lamps can emit significant EM disturbances to three, hence the title of this item.)

871) Avionics interference from PEDs (Passenger Electronic Devices)

ACN: 1242472 (7 of 50), Synopsis: B737 Captain reported possible interference from cell phones in the cabin that could account for the electronic anomalies they were experiencing during the flight.

ACN: 1219051 (9 of 50), Synopsis: B767 flight crew reported deviating from ILS course and altitude on approach to SPIM because of an autopilot error, possibly caused by passenger cell phone use.

ACN: 1159513 (10 of 50), Synopsis: Air Carrier Captain experiences localizer oscillations during approach in VMC that he suspects may have been caused by an electronic device.

ACN: 1128249 (11 of 50), Synopsis: CRJ-200 Captain experiences interference in his Bose X headset possibly caused by a cell phone.

ACN: 950259 (13 of 50), Synopsis: CRJ200 First Officer reports compass system malfunctions during initial climb. When passengers are asked to verify that all electronic devices are turned off the compass system returns to normal.

ACN: 754696 (21 of 50), Synopsis: IN AN APPARENT PED INTERFERENCE EVENT, A PAX'S PORTABLE GARMIN GPS MODEL NUVI 660 ALLEGEDLY INTEFERED WITH A B737 CLASSIC'S (NO GLASS) DME NAVIGATION UPDATE FUNCTION.

ACN: 702630 (29 of 50), Synopsis: CAPT OF AN A320 RPTS VHF INTERFERENCE ON ZOB ARTCC FREQ FROM A CELL PHONE ABOARD HIS PLANE.

ACN: 681689 (31 of 50), Synopsis: A B757-200'S L FUEL GAUGE BLANKED AFTER TKOF AND BECAME OPERABLE PRIOR TO LNDG. CREW SUSPECTS POSSIBLE PED INTERFERENCE.

ACN: 673795 (32 of 50), Synopsis: B737-800 FLT CREW EXPERIENCED SEVERAL TCAS RA'S ALLEGEDLY GENERATED BY A WI-FI ENABLED LAPTOP COMPUTER.

ACN: 661013 (33 of 50), Synopsis: FLT CREW OF CRJ-700 RPTS THAT AURAL INTERFERENCE IN VHF COMS CEASED WHEN PAX WERE ASKED TO ENSURE ALL FORMS OF 2-WAY COMS WERE TURNED OFF.

ACN: 609264 (42 of 50), Synopsis: B737-300 CREW HAD ERRATIC LOC SIGNALS ON ILS RWY 13 AND RWY 7 AT JAX. A PAX WAS USING A 'PALM PILOT' AT THE TIME.

ACN: 600964 (45 of 50), Synopsis: FLT CREW OF MD80 EXPERIENCE MISALIGNED HEADING INFO ON FMS DISPLAY. SUSPECT PAX OPERATED ELECTRONIC DEVICES.

(Taken from the NASA ASRS Database Report Set: “Passenger Electronic Devices”; Description: A sampling of reports referencing passenger electronic devices incidents”; Update Number: 27.0; Date of Update: January 29, 2016. NASA Ames Research Center, Moffett Field, CA 94035-1000, USA. NASA ASRS reports on PEDs (Passenger Electronic Devices) are available from: https://asrs.arc.nasa.gov/docs/rpsts/ped.pdf, but they are updated regularly so this URL does not return the January 29, 2016, report from which the above were taken. It is interesting to note that in this ASRS Report there were many reports of batteries or electronic devices overheating, leaking toxic fumes, melting, etc. far more than I remember from the earlier ASRS PED reports that featured in Banana Skins numbers 187, 188, 189, 467, 468, 487, 488 and 564. I don’t know where the superseded ASRS PED Reports are archived, or even if they are archived at all, but I have copies of all the ones that have been referenced in earlier Banana Skins if anyone needs them - Editor.)

872) Routers closer than 2 metres can interfere with LG 27-inch "Ultrafine 5K" display

Two years ago (www.edn.com/electronics-blogs/brians-brain/4438488/USB3-interferes-with-Wi-Fi-capabilities), I told you about ASUS' RT-N65 "N750" router family, whose 2.4 GHz Wi-Fi facilities were degraded to the point of unusability whenever a USB3 interface mass storage device was connected to it. Disconnecting the USB3 peripheral, or reconfiguring the router to run the USB interface at slower USB2 speeds, restored normal Wi-Fi functionality. The likely root problem, quoting from my earlier coverage, is "a lack of shielding around the router's wireless subsystem, thereby opening the door to destructive RF interference from the USB3 subsystem (which is also shield-less) and devices connected to it." And yes, an example of that particular router is still sitting in my teardown-candidate stack; stay tuned for the chance to peruse the shielding shortcomings for yourself, courtesy of my camera!

In recent days, I've encountered a similar situation, albeit somewhat in reverse. Apple's been whittling down its product plethora lately, not only turning its back on its longstanding networking equipment presence but also dropping its line of branded displays. Back in June of last year, the company discontinued its last LCD, a Thunderbolt-interface model; a couple of months later, Apple formalized a reference-sell relationship with LG Electronics. Only one problem, though; LG's 27" "UltraFine 5K" display (www.apple.com/shop/product/HKN62LL/A/lg-ultrafine-5k-display) tends to misbehave when in close proximity to a router. According to 9to5Mac's testing, the LCD begins to flicker when a router is approximately 2 meters (6.5 feet) away; any closer than that and the display will eventually go completely dark. The destructive interaction between router and display can in some cases be so severe as to lock up a connected computer, necessitating a restart even if the router is moved away again.

LG's Ultrafine 5K display, from www.apple.com/shop/product/HKN62LL/A/lg-ultrafine-5k-display

(Taken from http://www.edn.com/electronics-blogs/brians-brain/4458576/Electronics-interference--LG-displays-and-routers, by Brian Dipert on June 26, 2017 in the "EDN Network" www.edn.com. Kindly sent in by Ronny Deseine of Barco NV, Belgium, on 10 July 2017. Also see: https://tech.slashdot.org/story/17/01/30/2241256/lgs-ultrafine-5k-display-becomes-useless-when-its-within-two-meters-of-a-router, and https://9to5mac.com/2017/01/30/lg-ultrafine-5k-display-router-disconnecting/)

An LG spokesperson confirmed with Ars that the 5K UltraFine monitor isn't adequately shielded from EM radiation, and that displays manufactured after February 2017 "will be fitted with enhanced shielding." Furthermore, existing displays can be retrofitted with extra shielding—if you own the 5K UltraFine, and you're having issues, you should "contact your nearest customer service centre for prompt service." Curiously, the spokesperson said that the Wi-Fi router interference problem only occurs when the router is behind the display within a distance of 0.6m (2ft). LG didn't comment on the other issues that customers are reportedly experiencing. Apple still hasn't responded to our request for comment.

(Taken from "New 5K monitor sold by Apple apparently lacks EM shielding, has other issues" by Sebastian Anthony (UK) 1/31/2017, 2:04 PM, Updated, February 3: Downloaded 5 Feb 2017, https://arstechnica.com/gadgets/2017/01/apple-lg-5k-display-issues/.)

873) HDMI Cables and EMI

As more consumer and commercial products are introduced with High-Definition Multimedia Interface (HDMI) cable connections, the resulting EMI issues related to HDMI cable emissions have continued to be problematic for product designers and EMC engineers. It is very common to have one, or more, added HDMI cables cause a product to fail the radiated emissions (RE) test.

The reason EMI has reared up is that many brands of HDMI cables have poor cable shield bonds to the connector back shell. Unfortunately, it's not possible to simply purchase well-known cable brands and be assured of passing RE.

It's not uncommon for the shield to be tied to the connector back shell with a one-inch, or longer, pigtail connection. The problem has been with the original HDMI standard, developed by the HDMI Forum Technical Working Group. Unfortunately, the standard never completely addressed the best way to terminate the cable shield – that is, what we call in the business, a "360-degree" bond, where the shield is bonded in multiple places (ideally, all around the back shell) directly to the connector back shell (ground).

At high frequencies, pigtails can become highly inductive. For example, a one-inch pigtail (about 20 nH of inductance) can appear as a12-Ohm impedance. As the frequency increases, the impedance also increases. As the impedance increases, the cable shield essentially becomes "disconnected" from the connector ground and the result is cable emissions.

This issue has been dogging EMC engineers and compliance test labs for years. In 2008, Dana Bergey and Nathan Altland, both of FCI, authored a paper at DesignCON, entitled "EMI Shielding of Cable Assemblies", where they tested a number of cables for their EMI emissions properties when driven by a swept RF source. The cables were tested for emissions in a conventional mode-stirred chamber.

Looking at just the HDMI results, eight cables were tested and two of them had emissions some 20 dB higher than the other six. Dissecting these cables, it quickly became apparent as to the reason – and that was the pigtail issue as noted above. See Figure 1.

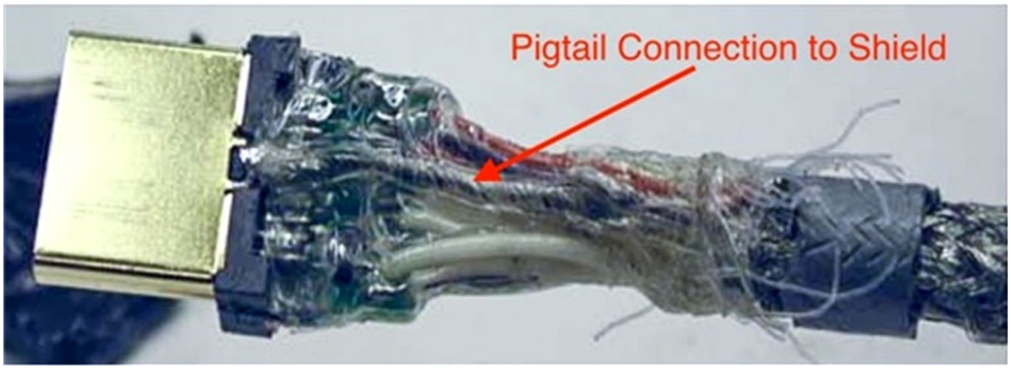

Figure 1 – A poorly terminated HDMI cable shield using a long pigtail connection.
Image, courtesy Dana Bergey and Nathan Altland.

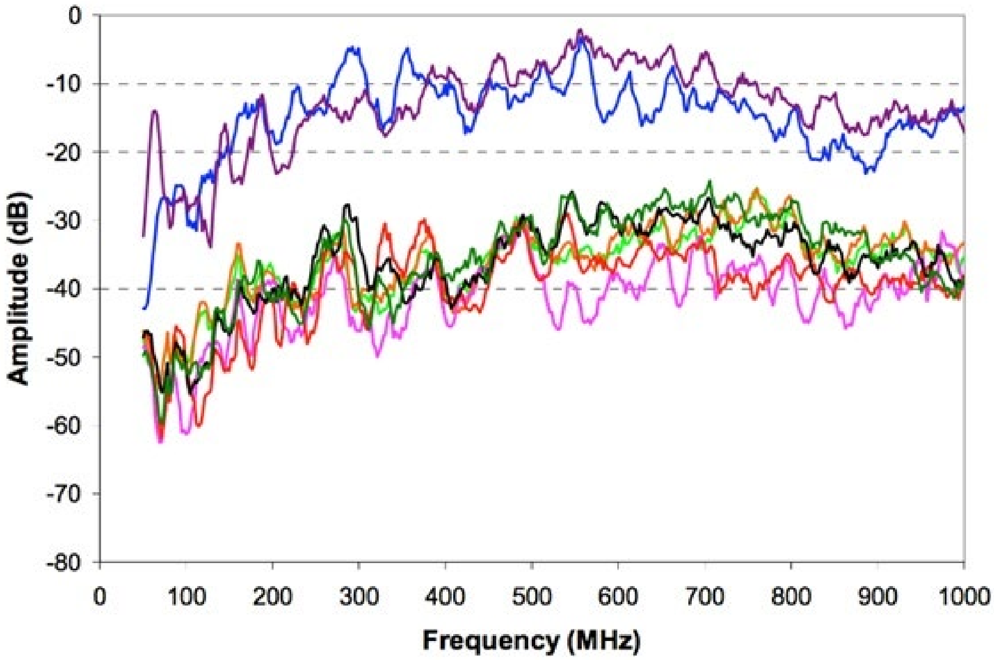

Figure 2 – The resulting radiated emissions from a sample of eight HDMI cables. Two of the samples exhibited EMI 20 dB higher than the average. Image, courtesy Dana Bergey and Nathan Altland.

I recently contacted Brad Bramy, HDMI Licensing Administrator, to determine whether the working group was aware of the issue and whether the current standards development would be resolving this through a more rigorous EMI-worthy assembly procedure. He passed my questions on to the working group. Here was the official reply:

1. What exactly does the current HDMI specification say about this ground connection?

• The HDMI 1.4b specification governs current cable specifications, which were developed by the HDMI Founders. The Forum is not authorized to comment on the HDMI 1.4b specification or its content. HDMI LA works directly with the Founders and will be the best resource for you to get these questions answered.

2. Does the newer version 2.1 spec address this better?

• HDMI 2.1 does introduce a new cable with improved overall performance (The current working marketing name is the 48G HDMI Cable). However, since the specification remains under final development, the Forum cannot yet comment on specific details.

3. Is the working group aware of this problem and are there any plans to remedy this issue?

• The HDMI Forum Technical Working Group is aware of concerns about the current cable specifications. However, since the specification remains under final development, the Forum cannot yet comment on specific details.

While I'm encouraged that the working group is aware of the concern, time will tell whether future releases of the standard will address this issue. Let's hope so! In the meantime, you'll need to secure a range of high-quality HDMI cables and try them one at a time to find the best one to use for EMI testing – not an ideal solution.

References:

1. Bergey and Altland, EMI Shielding of Cable Assemblies, DesignCON 2008, http://www.magazines007.com/pdf/DC08_Dana_Bergey.pdf.

2. HDMI Forum Technical Working Group, http://www.hdmi.org.

(Taken from Kenneth Wyatt's Blog at Interference Technology magazine, "HDMI Cables and EMI", July 3, 2017, Cable & Connectors, Featured, https://interferencetechnology.com/hdmi-cables-emi/)

874) Error in EMC test standard causes non-compliant equipment to be placed on the market

We were recently presented with an electromechanical device powered by 230V 50Hz, to be tested against the requirements of IEC/EN 60947-4-1. In that standard there is a referenced clause (7.3.2.1 of EN 60947-1) that states that if the product does not incorporate any so called 'electronic circuits' then testing is not required, see Figure 1.

BS EN 60947-1:2007+A2:2014
IEC 60947-1:2007+A2:2014 (E) – 74 –

For the purpose of this standard, the phrase "electronic circuit" excludes circuits in which all components are passive (including diodes, resistors, varistors, capacitors, surge suppressors, inductors).

7.3.3 Emission

7.3.3.1 Equipment not incorporating electronic circuits

The requirements for electromagnetic emissions for equipment not incorporating electronic circuits are deemed to be satisfied, and no verification is necessary.

Figure 1 Extracts of relevant text from Subclause 7.3 in IEC/EN 60947-1

We almost called off testing on the basis that the device only apparently contained only a bridge rectifier and solenoid (which seemed to conform to the list of passive components further defined in the parent standard EN 60947-1), but as the customer had been specifically asked to get the testing done for their client we progressed anyway.

We were then surprised to be presented with this (see Figure 2) for conducted emissions:

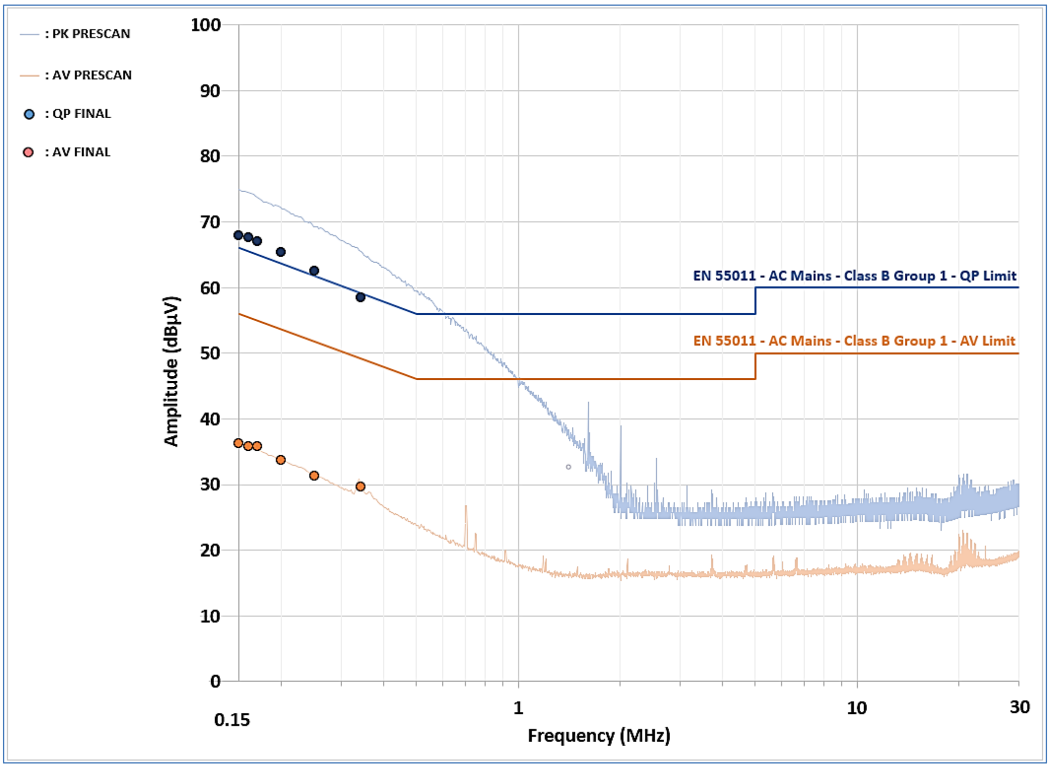

Figure 2 Conducted emissions plots, blue = QP, brown = AV

We set up the spectrum analyser in zero span in conjunction with an oscilloscope (with a shared trigger) and confirmed that the emission occurred at zero crossing, see Figure 3.

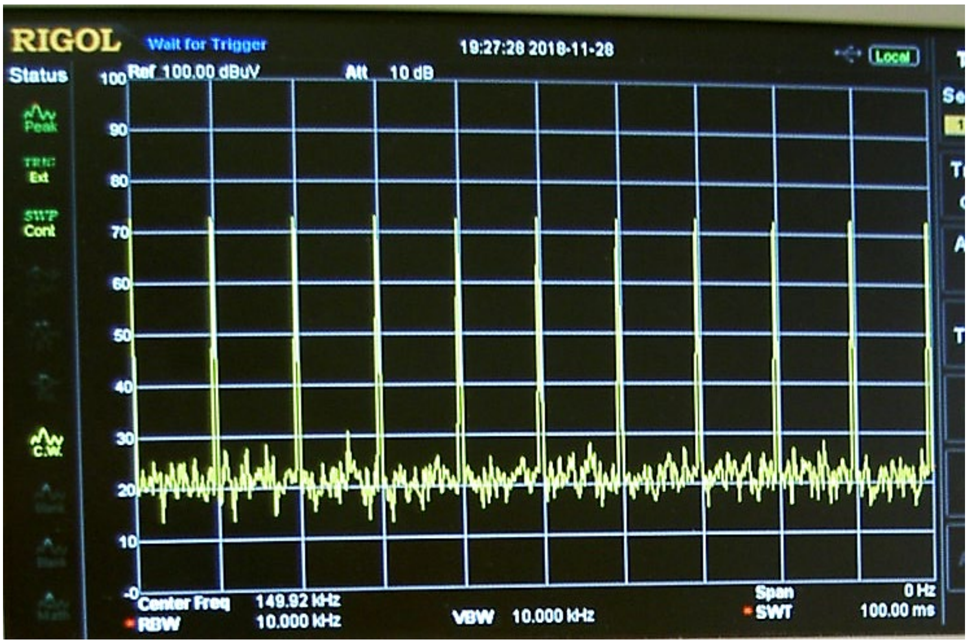

Figure 2

All this from a bridge rectifier?

Subsequent investigations revealed that there are two contributors to rectifier noise, but we usually never see them because they are swamped by the noise emissions from switching power converters, and the mains filters required to make them EMC compliant reduce the rectifier noise to below the noise floor. Of course, the product was an entirely passive device except for its bridge rectifier, and had no mains filter.

The two noise sources in silicon PN junction rectifiers are:

i) The deadband in diode conduction caused by their silicon's 0.7V band-gap voltage

ii) The 'reverse recovery time' of the rectifier's PN-junctions' minority carriers (usually called 'holes'), which even in reasonably fast 1A silicon rectifiers causes them to continue to conduct for several hundred nanoseconds, perhaps even for as long as 1.8 microseconds, *after their voltage has reversed*.
However, due to the slow rate of change of the 50Hz mains waveform this is not a significant source of noise for off-line rectifiers, although it usually is a big problem for the fast-switching rectifiers required in switching power converters.

We wonder how many similarly non-compliant items of equipment have been placed on the market, but never tested for EMC as a result of the passive components/ 'electronic circuit' clause referenced above?

We have amended our internal procedures for this product class to include a precautionary conducted emissions measurement for all samples submitted for assessment against this standard. We also intend to raise it with our trade association to find out what similar experiences other labs have had, and whether there may be grounds to re-assess this entry to the standard.

(Kindly sent in by Product Approvals Ltd, Telford, www.productapprovals.co.uk/ on 28 November 2018. The Editor adds: I have seen the noise from a bridge rectifier alone, in a 4kW linear power supply, exceed the QP limit all the way up to 4MHz.)

875) DAB radio interfered with by LED lighting

Just FYI: I was called and interviewed by the Belgian radio on the question why the DAB+ radio of one of their listeners always stopped working when he switched on his new LED lights.

(Kindly sent in by Prof. Davy Pissoort, Assistant Professor, Mechatronics Group, KU Leuven, Belgium, on 12 December 2017, https://iiw.kuleuven.be/brugge/m-group.)

CHERRY CLOUGH CONSULTANTS LTD

876) FCC Ends Heater Interference to Aircraft Radio on Coast

The Proceedings of the IEEE – June 1967 had a special issue on Radio Measurement Methods and Standards. An article of particular interest was “Electromagnetic Compatibility Measurements” by R. M. Showers and O. M. Salati.

Public Notice G 1844, under the above title, is as follows: “The FCC has eliminated a serious source of interference to aircraft radio transmission in the Los Angeles and San Francisco areas. The interference, caused by industrial heaters, resulted in severe difficulties for commercial and private aircraft and was a matter of serious concern to the FAA.

FCC engineers, called in to locate and eliminate the source of the interference, set up a series of spotting flights. Using direction finding equipment, they were able to spot 16 heaters, 12 of which were causing interference in flight communications. Contacts with the firms using the heaters resulted in action being taken to eliminate the interference.

Industrial heaters are electronic devices in manufacturing operations requiring very rapid drying. The firms using the heaters causing the interference were manufacturers of such diverse products as plywood, plastics, rubber mats, handbags and eyeglass cases.

The interference can generally be eliminated by shielding the heater equipment properly.”

(This is an extract from: “50-25-10 Years Ago: A Review of EMC Society Newsletters”, by Daniel D. Hoolihan, Associate Editor, in: 2017 IEEE Electromagnetic Compatibility Magazine – Volume 6 – Quarter 4, on page 41. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8272278.)

877) Even NASA get it wrong!

NASA’s human-shaped ‘robonaught’, deployed on the ISS, suffered a series of problems and eventually stopped working. The problem was eventually traced to a missing ‘ground wire’, see: https://spectrum.ieee.org/automaton/robotics/space-robots/robonaut-has-been-broken-for-years-and-now-nasa-is-bringing-it-home#.Wt7aqYdu3W0.mailto (the missing ground wire is only mentioned near the end).

(Kindly sent in by Paul Ruzic from Australia, on 1 May 2018.)

878) First admission that EMI could cause autonomous cars to crash

The promise of self-driving cars is speeding ever closer to fruition, but as evidenced last week, automakers and tech companies still have quite a bit of work to do to ensure that these cars are actually safe for the road. Mobileye, one of the major firms manufacturing the driver-assistance systems responsible for getting cars to drive themselves, recently announced debuted a new fleet of prototype vehicles that would be able to make their way through cities and across streets without using lasers or radars — an impressive feat.

Unfortunately, at a press event in Jerusalem meant to show off the capabilities of this new autonomous system, a test car drove straight through a red light. Needless to say, this wasn’t the outcome Mobileye was hoping for.

Luckily, no one was hurt in the incident, and this was the only hiccup in the test run. Still, it was clearly a rather alarming mistake to make. Camera footage shows that a Mobileye safety driver was inside the vehicle monitoring its actions, but for some reason, allowed the car to continue through the stoplight without taking action.

According to the company’s chief executive officer, Amnon Shashua, the reason behind the mistake was electromagnetic interference. As Bloomberg reported, “wireless transmitters on cameras used by the television crew created electromagnetic interference, which disrupted signals from a transponder on the traffic light.” Consequently, even though the car’s camera realized that the light was red, the car itself ignored this information and continued to drive as per signals sent from the transponder. Shashua says that this issue has since been addressed.

“It was a very unique situation,” he said. “We’d never anticipated something like this.” Shashua added that Mobileye is also making tweaks to the hardware meant to protect the car’s computers from electromagnetic interference with hopes of ensuring that similar incidents do not occur in the future.

Alas, this is by no means the first time that a self-driving car has run into this sort of issue. Uber had a similar problem in 2016, when a driverless car was caught running a red light. And just two months ago, a YouTube video seemed to show a Waymo car going through a red light after initially stopping and trying to make a left turn.

In any case, these issues will clearly have to be sorted out before autonomous cars are trusted to transport human passengers.

(Taken from: 'Mobileye tries to show off self-driving car, runs a red light instead' by Lulu Chang@luchanglu, in Digital Trends on-line magazine, www.digitaltrends.com/cars/mobileye-red-light/ and sent in by Professor Davy Pissoort of the M-Group (Mechatronics Group) at KU Leuven, Bruges, Belgium, https://iiw.kuleuven.be/brugge/m-group on 28 March 2018.)

879) RFID can interfere with non-implantable medical devices

Background: The use of radiofrequency identification (RFID) in healthcare is increasing and concerns for electromagnetic compatibility (EMC) pose one of the biggest obstacles for widespread adoption. Numerous studies have documented that RFID can interfere with medical devices. The majority of past studies have concentrated on implantable medical devices such as implantable pacemakers and implantable cardioverter defibrillators (ICDs). This study examined EMC between RFID systems and non-implantable medical devices.

Methods: Medical devices were exposed to 19 different RFID readers and one RFID active tag. The RFID systems used covered 5 different frequency bands: 125–134 kHz (low frequency (LF)); 13.56 MHz (high frequency (HF)); 433 MHz; 915 MHz (ultra high frequency (UHF])) and 2.4 GHz. We tested three syringe pumps, three infusion pumps, four automatic external defibrillators (AEDs), and one ventilator. The testing procedure is modified from American National Standards Institute (ANSI) C63.18, Recommended Practice for an On-Site, Ad Hoc Test Method for Estimating Radiated Electromagnetic Immunity of Medical Devices to Specific Radio-Frequency Transmitters.

Results: For syringe pumps, we observed electromagnetic interference (EMI) during 13 of 60 experiments (22%) at a maximum distance of 59 cm. For infusion pumps, we observed EMI during 10 of 60 experiments (17%) at a maximum distance of 136 cm. For AEDs, we observed EMI during 18 of 75 experiments (24%) at a maximum distance of 51 cm. The majority of the EMI observed was classified as probably clinically significant or left the device inoperable. No EMI was observed for all medical devices tested during exposure to 433 MHz (two readers, one active tag) or 2.4 GHz RFID (two readers).

Conclusion: Testing confirms that RFID has the ability to interfere with critical medical equipment. Hospital staff should be aware of the potential for medical device EMI caused by RFID systems and should be encouraged to perform on-site RF immunity tests prior to RFID system deployment or prior to placing new medical devices in an RFID environment. The methods presented in this paper are time-consuming and burdensome and suggest the need for standard test methods for assessing the immunity of medical devices to RFID systems.

(Extracted from 'Adhoc electromagnetic compatibility testing of non-implantable medical devices and radio frequency identification', a paper by Seth J Seidman and Joshua W Guag, in BioMedical Engineering OnLine 2013, http://www.biomedical-engineering-online.com/content/12/1/71, which was kindly sent to the Editor by Jeff Silberberg of the US Food & Drug Administration (FDA) in June 2018.)

880) LED lighting on ships can interfere with marine VHF communications

During periodical inspections of GMDSS equipment and AIS performed by the National Frequencies Agency on board ships, crews and shipowners reported problems regarding reception on VHF frequencies (radiotelephone / DSC and AIS) when navigation lights are switched on or during the use of other system of lighting (i.e. searchlights).

Occurrence of these problems coincides with the replacement of classical lighting by LED lamps. Many internet yachtsmen forums also describe similar problems.

(From the Editor, who came upon this in the ITU liaison report 5B/TEMP/220, "EMI standards for LED lighting" dated 13 June 2018. Visit http://f6hcc.free.fr/lampesled_fichiers/led_vhf_marine.pdf dated 4 March 2015 and in French, for the official report referenced in this ITU liaison report.)

881) Superconducting quantum interference device (SQUID) suffer EMI from an overhead light

Our original system for detecting the magnetic nanoparticles was based on a superconducting quantum interference device (SQUID) sensor that operated in liquid nitrogen, and although we managed to cope with supplying liquid nitrogen to the operating theatres during the clinical trials, it was a hell of a nuisance. There were issues even with small things like taking nitrogen up and down in a lift – people get quite exercised about the possibility of spillages in small spaces.

Also, SQUIDs are very sensitive to radio frequency fields, and under certain circumstances they will become completely non-operative if there's a sufficient level of background interference, however good your screening is – and we spent a long time trying to produce good screening.

On one occasion, the SQUID simply failed to tune in the operating theatre, and it was only after the operation was over (all the trials were done using both the radioactive technique and our magnetic technique) that we worked out that the radiofrequency interference was coming from one of the overhead lights. If I'd known that and I'd been able to turn off that one set of lights, we'd have been able to continue, but that lack of robustness in a system you're hoping to market everywhere is just not going to be acceptable.

Then there's the fact that not many companies make SQUIDs that work at liquid-nitrogen temperatures – and of course, the low-temperature ones, which require liquid helium, were completely out of the question.

Eventually, I managed to work out a way of doing our measurements with room-temperature electronics by pushing up the frequency to increase the level of sensitivity, using really low-noise amplifiers and developing our correlation techniques a bit more.

(Kindly sent in by Richard Marshall, who saw it in the article "Tracing the spread of cancer" in the 2018 Physics World Focus on Biomedical Physics, at https://physicsworld.com/a/tracing-the-spread-of-cancer.)

882) Cellphone voice recognition system spoofed by 500mW IEMI attack around 230MHz

In this study, we presented a new technique for remote and silent voice command injection in a specific model of smartphones based on conducted propagation and back-door coupling phenomena. This technique is complementary to the existing one based on radiated propagation and front-door coupling and allows compromising different targets, from a longer range and with less emitted power.

By characterizing different configurations of the propagation path, it was shown that a proper voice command injection is achievable with a reduced effect of the elements on the propagation path. Finally, this study highlights a potential attack vector on VCIs, demonstrating that a stealth unauthorized exploitation of this UI is possible, attracting the attention of both vendors and users on its criticality and emphasizing the need to secure it and to use it wisely.

More EMC/EMI analysis is required in order to have a better understanding of the power network random configurations on the efficiency of the attack scenario. Moreover, as proposed in this study, the experimental set-up can be used to characterize other devices in order to check the exploitability of this attack path against other Smartphones.

(Taken from the paper: "System Design & Assessment Note SDAN 48, April 2018, Remote and Silent Voice Command Injection on a Smartphone through Conducted IEMI – Threats of Smart IEMI for Information Security" by José Lopes Esteves and Chaouki Kasmi of the Wireless Security Lab, French Network and Information Security Agency – ANSSI, which is available from: http://ece-research.unm.edu/summa/notes/SDAN/SDAN0048.pdf.

They found that the conducted noise coupling from the mains side of the charger to the microphone signal was almost 0dB around 230MHz! Making it easy to put RF on the mains or the USB power modulated with voice commands that the cellphone assumes were actually spoken. It only required 500mW of RF power to spoof a voice recognition system.)

883) New Hitachi 'Azuma' trains cause EMI to older signals and points in the north of England

New trains planned for the East Coast mainline do not work properly with track-side equipment, it has emerged.

The Azuma trains cause electromagnetic interference to older signals and points in the north of England. This means the electro-diesel trains can only run on diesel, travelling much more slowly than their promised speed.

Network Rail said it was working with Japanese train manufacturer Hitachi to fix the problem but it was too early to identify a solution. "We are committed to delivering improved passenger services and are working on a long-term solution," a spokesperson said. "In the meantime, the new trains continue to be tested on the East Coast mainline."

The problem affects equipment that registers passing trains and instructs signals and points accordingly. The older system used on the line north of York does not work with the new trains when they operate on electric power.

Former Labour transport secretary Lord Adonis said he had ordered the new trains 10 years ago. "They had 10 years to get these signalling issues right," he added. "They'll be much more expensive to operate, they'll be slower, they'll have less capacity and hundreds of millions of pounds of public money has been wasted again. "This should be sorted out and it's [transport secretary] Chris Grayling's responsibility."

Mr Grayling admitted there were "teething problems in the same way we had teething problems on the Great Western line". He said: "We have started to move towards greater integration between track and trains. The new franchises involve much closer working between Network Rail - the track operator - and the train companies. "The North needs and deserves better railways. It's getting new trains, it's getting investment, it doesn't happen overnight."

The new trains are being assembled at Hitachi's plant in Newton Aycliffe in County Durham. At expected speed they would reduce the journey time from Edinburgh to London by 22 minutes to four hours, the company said. Network Rail said they were still due to be rolled out by the end of the year. It added: "Electromagnetic emissions from the train are interfering with existing safety critical systems - a fact confirmed by the independent report. "It is Hitachi's responsibility to demonstrate that the IEP trains can run safely on the East Coast mainline, and we believe that this issue can only be fixed on the train."

itachi said: "There are a number of 30-year old signalling systems on the East Coast mainline which require modifying to operate with modern electric trains - which has been confirmed by an independent report. Network Rail is planning to carry out this modification work before the Azuma trains enter into passenger service. This is the same issue encountered 15 years ago when the Pendolino was introduced on the West Coast mainline. Whilst testing started over 12 months ago, this issue has been identified by Network Rail only recently during multi-train testing. Hitachi is working hard to support Network Rail to overcome this interface issue".

(Kindly sent in on 10 September 2018 by Dr Antony Anderson, an independent consultant based in the north of England, who saw it on the BBC News, https://www.bbc.co.uk/news/uk-england-tyne-45435683.)

884) A new equipment caused half the other equipment in a factory to malfunction

I once had to deal with a new machining centre in a factory, that put 15Vp-p on the mains at 20kHz when it was operated, causing more than half of the other equipment in the factory to malfunction.

20kHz was the 5th harmonic of the machining centre's 55kW 4kHz variable-speed motor drive (VSD), but the fundamental and harmonics below the 5th were not a problem, even though they probably had higher levels of energy in them.

This pointed to a resonance in the interaction of the filter with its complex source impedance, causing a significant gain (rather than attenuation) at or near 20kHz.

The solution turned out to be quite quick and easy. The 55kW motor drive was a Siemens type, but the manufacturer of the machining centre had chosen to use a cheaper mains filter than the one Siemens recommended for use with their drive.

The cheaper mains filter had allowed the machining centre to pass emissions tests above 150kHz, but the manufacturer had only thought about passing the tests – not about the fact that the VSD's rather high-power noise emissions at its switching frequency of 4kHz and its harmonics – 8kHz, 12kHz, 16kHz, 20kHz, etc. – might cause EMI problems in real-life at frequencies below 150kHz.

Retrofitting the filter that Siemens recommended for their motor drive reduced the 20kHz noise to below 1.5 Vp-p, didn't cause any other noises to become significant, and immediately solved the problem throughout the factory.

(Provided by Keith Armstrong, November 2018. He also notes: "All filters are specified by testing with 50Ω resistive source impedances for both differential-mode (DM, which the filter industry calls 'symmetrical') and common-mode (CM, which the filter industry calls 'asymmetrical'). In real life, of course, neither the DM or CM source impedances are likely to even be close to 50Ω, and even then are very much more likely to be capacitive or inductive depending on the frequency, than resistive. So it is not that unusual for a mains filter in real life to <u>amplify</u> certain frequencies instead of attenuating them, because of its 'mis-matched' source impedances. The very real possibility of similar real-life problems with their risks of claims under contract penalty clauses or high warranty costs is obscured by the fact that EMC test methods used on finished products or equipment use LISNs or AMNs that create the unrealistic 50Ω resistive source impedances for both DM and CM.")

885) The lack of IC ESD sensitivity data has reached a critical stage

With the downward trend in IC ESD thresholds as discussed, it is essential to know, prior to initial production, when component sensitivities fall outside the scope of the document. The absence of device ESD sensitivity data in the public domain has reached a critical stage and will only worsen with technology trends towards the expanding use of extreme ESD sensitivities.

Therefore, it is strongly recommended that manufacturing quality executives require notification of any such devices to avoid a production crisis such as the case study described above.

Likewise, it is strongly recommended that IC suppliers make the data readily available either in publicly available data sheets utilizing the standard practice being developed by EOS/ESD Association, Inc. or in other documentation in the case of custom devices.

(The conclusions of Ted Dangelmayer, writing on behalf of the EOS/ESD Association, Inc., in "Absence of IC ESD Sensitivity Data Has Reached a Critical Stage", in In Compliance magazine, October 2018 edition, visit: https://incompliancemag.com/article/absence-of-ic-esd-sensitivity-data-has-reached-a-critical-stage/)

886) Always avoid using 1kHz clock frequencies!

A company just couldn't get their device through the immunity test. I very quickly discovered that it was because their main clock frequency was 1kHz, identical to the sine-wave modulation used in the tests.

(Kindly sent in by Prof. Davy Pissoort, Assistant Professor, Mechatronics Group, KU Leuven, Belgium, on 20 Nov 2018, https://iiw.kuleuven.be/brugge/m-group.)

887) Your Tesla can go from zero to 60mph in 2.5s, but can't get AM radio

Electric-powered motors interfere with AM reception, prompting some car makers to drop the dashboard option; 'I was so mad I told them to take the car back'.

The problem, experts said, is that electric-vehicle motors generate electromagnetic frequencies on the same wavelength as AM radio signals. That creates the buzzing and signal fading from electromagnetic interference.

"You get two signals that literally collide into each other and cancel each other out before the antenna even receives the signal," said Brian McKay, head of engine innovation and technology at the North American operations of Continental AG. As EV motors grow more powerful, so does AM static.

(Taken from the Wall Street Journal, 11 September 2018, visit https://www.wsj.com/articles/your-tesla-can-go-zero-to-60-in-2-5-seconds-but-cant-get-am-radio-1541523098 for the full article.)

888) Emissions between 2kHz and 150kHz can cause overheating and audible noises

Abstract: Due to the increasing use of modern technologies (e.g. PWM inverters in PV installations, equipment with active power factor correction circuits, PLC, …) the emission levels in the frequency range between 2 kHz and 150 kHz are rising continuously. In the recent time the number of reported disturbances (e.g. malfunctions of coffee machines, audible noise of electronic ballasts) caused by this emission is growing. Beside these obvious interferences the question arises, if electronic mass-market equipment is affected by this higher frequency (HF) emission as well.

Especially in shunt elements with low impedance at higher frequencies, like DC-link capacitors in rectifier circuits, larger high frequency currents can occur, which may result in additional thermal stress and lifetime reduction.

Based on a laboratory setup the paper analyses the impact of HF components in the supply voltage on the operating temperature within different lamps with electronic ballast. Using a laboratory setup the frequency-dependent input behaviour of different electronic equipment was measured up to 50 kHz. For selected lamps detailed temperature studies were carried out.

Conclusions: The paper demonstrates that HF voltages can have a significant impact on the thermal stress and subsequently the life time of electronic equipment, which contains rectifiers with electrolytic capacitors as DC link. Especially the equipment without active cooling has shown a significant impact of the HF voltages on operating temperatures.

Therefore the discussion about immunity and emission levels should not only consider obvious malfunctions but also take the possible long-term effects as described in the paper into account. Besides the additional heating, especially audible noise was observed for a lot of the analysed equipment. This can occur already at HF voltage levels of about 1%.

From the viewpoint of additional thermal stress and disturbing audible noise the compatibility levels in the frequency range up to 20 kHz should be considerably low. Anyway, it should be lower than those levels that already cause obvious equipment malfunctions. Moreover, it is suggested to introduce a limit for the whole frequency band (similar to THD) too.

Currently the measurements are extended to other equipment (e.g. PC power supplies) and to test voltage waveforms containing more than one HF component. Long-term experiments for an assessment of possible lifetime reductions are planned.

(Taken from "Impact of Higher Frequency Emissions above 2kHz on Electronic Mass-Market Equipment", by Jan Meyer, Stephan Haehle and Peter Schegner of the Technische Universitaet Dresden, Germany, CIRED 22nd International Conference on Electricity Distribution Stockholm, 10-13 June 2013, Session 2 Paper No 0999, available from https://ieeexplore.ieee.org/document/6683630.)

889) Photovoltaic active infeed power converters can interfere with power line communications

Field measurements, laboratory tests and simulation have shown that some inverters dedicated to photovoltaic energy production do interfere with power line communication systems.

A method was presented to assessing interferences in the CENELEC A band with the help of frequency scans of equivalent circuits modelling LV grid components, active infeed converters and loads. The proposed method was evaluated on the basis of simulations and measurements realised on a simple laboratory setup.

The results revealed that EMC-filters for PV inverters can play an important role on signal attenuation, if resonances are located close to the frequency used by the PLC system.

(Taken from "Electromagnetic Interferences in Smart Grid Applications: A Case Study With PLC Smart Meters and PV Energy Generation", by Dominique Roggo, Rodolfo Horta, Lino Capponi, Loïc Eggenschwiler, Fabrice Decovert, Cédric Pellodi and Franz Buholzer, presented at the 24th International Conference on Electricity Distribution Glasgow, 12-15 June 2017, CIRED 2017, paper 1285, which is available from https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=8315836.)

890) FAA restrictions for use of electronic devices aboard aircraft, October 2017

7.2.2 Aircraft Not Designed and Certified PED Tolerant. An operator may choose to conduct a safety risk assessment following the process in RTCA DO-363 if it 1) does not have a designed and certified PED-tolerant aircraft, and 2) chooses not to test its aircraft fleet types according to RTCA DO-307A or obtain supporting documentation from an aircraft manufacturer. The operator's assessment must evaluate the avionics configuration of its fleet and failure modes of communication, navigation, surveillance, and other electronic systems with respect to electromagnetic interference. This assessment ultimately outlines mitigations and controls the operator needs to adopt to expand PED use into various phases of flight.

7.2.3 Aircraft Not Demonstrated PED Tolerant. If the operator has not demonstrated PED tolerance for their aircraft, they may allow PED operation during cruise flight. If interference to aircraft systems from PEDs is experienced during cruise flight, the devices causing interference should be isolated, and applicable conditions recorded. The device responsible for the interference should be turned off.

(Taken from: "Use of Portable Electronic Devices Aboard Aircraft", U.S. Department of Transportation, Federal Aviation Administration Advisory Circular, 10/27/17, AC No: 91.21-1D, available from: https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_91.21-1D.pdf.)

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Glossary of terms and abbreviations

These descriptions are provided as an aid to understanding

Formal definitions may be found in the IEC International Electrotechnical Vocabulary

Ω	Ohms
μ	Micro, one part in a million, 10^{-6}
A	Amps
AC	Alternating current
A/m	Amps/metre, a unit of magnetic field strength, usually used for RF fields
BOM, Bill Of Materials	The list of parts and materials required to construct something.
BOM cost	The overall cost of the parts and materials required to construct something.
CB	Citizen's Band. A band of frequencies within the 27MHz ISM band, used for walkie-talkies and vehicle-mounted radio communications with few restrictions on use.
CE marking	A form of mark that indicates that a product is claimed by its supplier to comply with all relevant EU Directives, such as the EMC Directive.
CISPR	A branch of the IEC devoted to producing EMC test standards.
CM, Common-mode	A term used to describe voltages and/or currents that apply identically to all the conductors (including return conductors and shields) associated with a cable, or with an item of equipment. CM voltages or currents are always unwanted noise, and are associated with many EMC issues. CM voltages and currents are measured with respect to a remote reference, such as the metal floor of a shielded room in which the tests are being conducted.
Conducted	When applied to emissions or immunity, this term refers to unwanted EM energy conducted from equipment via the power supply or data, signal or control conductors.
Conducted emissions	Energy transmitted as EM waves along a cable or other conductor. Most countries have mandatory limitations on conducted emissions into their electrical power supply networks, to help reduce interference with other electronic equipment. Because conducted EM waves are a cause of radiated EM waves, these limitations also help protect licensed users of the radio spectrum.
Continuous disturbance	A disturbance which cannot be resolved into a succession of distinct events by measuring equipment. For transient disturbances, this term is typically applied to disturbances that occur more than 30 times a minute on average.
CRT	A type of VDU based upon a Cathode Ray Tube.
DC	Direct current
DM, Differential-mode	The mode of conduction of voltages and/or currents associated with intentional (wanted) power, signals, data, etc. A DM voltage is created on a conductor with respect to a different one in the same cable or item of equipment. A DM current flows conductor and returns by a different one in the same cable or item of equipment.
Disturbance	Unwanted EM energy, which may or may not cause a problem to victim equipment. Disturbances may be produced by either intentional or spurious sources, from equipment, or by natural causes (e.g. lightning, or electrostatic discharge).
DSP	Digital signal processing, or digital signal processor.

Earthing	See Grounding.
Electromagnetic environment	The totality of the continuous and transient electric, magnetic, and EM fields, conducted EM energy, and electrostatic discharges at a given location.
EM, Electromagnetic	All electrical and electronic phenomena (signals, data, power, etc.) and radio waves are electromagnetic in nature – their energy flows as both electric energy (e.g. that flows in the electric field between the plates of a capacitor due to fluctuating voltages) and magnetic energy (that flows in the magnetic field due to fluctuating currents).
EM wave	All EM energy travels in the form of waves, whether it is associated with electrical power, signals, data or control. In a conducted EM wave, the magnitudes of the voltages and currents vary along the conductor. In a radiated EM wave the magnitudes, the magnitudes of the electric and magnetic fields vary with position in three-dimensional space.
EMC, Electromagnetic Compatibility	The ability of equipment or a system to function satisfactorily in its electromagnetic environment: - without introducing intolerable EM disturbances into that environment, and: - without suffering unacceptable degradation of performance due to the EM disturbances present in that environment.
EMC Directive	Legal instrument by which all member states in the European Union (EU) are obliged to enact national laws that have the same effect, to restrict the supply of electrical and electronic goods in the EU to those that meet certain minimum requirements for electromagnetic emissions and immunity.
EMI, Electromagnetic interference	Degradation of functional performance caused by inadequate immunity to EM disturbances.
ESD, Electrostatic discharge	A sudden transfer of electric charge from one body to another, usually because of the voltage breakdown of the air between them (a spark). The dissipation of the charge causes transient disturbing currents to flow, and the spark is a source of very wideband radiated emissions.
EU, European Union	A trade bloc based in the continent of Europe.
Fast transient	Usually used to describe an impulse with a risetime of under 100ns on power or signal cables. Most likely to appear in the form of a burst of such transients, generally caused by sparking at electromechanical contacts, hence 'Fast Transient Burst'
FCC	The U.S.A.'s Federal Communications Commission, responsible for creating the USA's EMC regulations and setting standards for the protection of the EM environment, and also for enforcing those laws and standards.
FDA	The U.S.A.'s Food and Drug Administration, responsible for ensuring the safety of medical equipment, as well as drugs.
Field, EM field	As a radiated EM wave propagates in three-dimensional space the magnitudes of its electric and magnetic waves can be represented as varying fields. Electric field strengths are measured in Volts/metre (V/m) and Magnetic field strengths in Amps/metre (A/m).
Filter	A combination of capacitors, inductors, RF absorbers and/or resistors intended to reduce the amount of EM energy at certain frequencies from being conducted along a cable or wire.

G, Gauss	A unit of magnetic field strength, usually used for DC and low-frequency magnetic fields
GHz	Gigahertz, units of thousands of millions (10^9) cycles per second
GW	Gigawatts, units of thousands of millions (10^9) of Watts
Grounding	In EMC terms, the interconnection of reference circuits to present a low impedance reference for signal or filtering circuits, and so minimise noise. A ground may or may nor be at the potential of the earth mass, and is not necessarily the same as the safety earth or protective conductor. Sometimes called earthing instead. The use of similar terms in electrical safety engineering often leads to confusion.
HSE	The U.K.'s Health and Safety Executive, responsible for health and safety issues in the workplace.
HV	High Voltage (above 1kV rms AC, or 1.5kV peak DC)
Hz	Cycles per second
IC	Integrated Circuit
IEC	International Electrotechnical Commission. Creates standards for EMC emissions and immunity, and safety, amongst other things.
IEMI	Intentional EMI, used by bad people, unless it is us using it
I/O	Input/Output
Interference	The degradation in performance, malfunction or damage that is the result of inadequate immunity to EM disturbances.
ISM	A number of frequency bands set aside for use by industry, medicine or science. Since there are no licensed radiocommunications in these bands, the emissions from the ISM equipment or systems should cause no interference with licensed users of the radio spectrum. The levels of EM emissions permitted in the ISM bands by the relevant standards (CISPR11, EN 55011, etc.) can be very high indeed, sufficient to cause health hazards to personnel, and to interfere with almost any kind of electronic (possibly even electrical) devices, equipment and systems – even though the ISM equipment concerned legally bears the CE marking..
kHz	kilohertz, units of thousands (10^3) of cycles per second
kW	kilowatts, units of thousands (10^3) of Watts
LCD	Liquid Crystal Display, used for displaying text and/or graphics. If used as a computer monitor they can be called a VDU.
MDA	See MHRA
MHRA	The U.K.'s Medicines and Healthcare Products Regulatory Agency, now incorporates what used to be called the Medical Devices Agency, MDA, responsible for the safety of medical devices, equipment and systems.
MHz	Meghertz, units of millions (10^6) of cycles per second
MW	Megawatts, units of millions (10^6) of Watts
PCB, Printed Circuit Board	A laminated structure of layers of etched foil conductors (usually copper) known as tracks or traces, interspersed with layers of dielectrics (often a glass-fibre matrix). Also known as a Printed Wiring Board (PWB). The traces are interconnected between layers by plated-through holes (PTH) known as via holes. Electronic components are mounted onto the PCB and soldered to the traces on the outermost layer(s). Components with long pins or leads may be connected directly to traces on inner layers by plated through holes.

Radiated emissions	Energy transmitted as EM waves in the air or other dielectrics. Most countries have mandatory limitations on radiated emissions, to help reduce interference with other electronic equipment, and to protect licensed users of the radio spectrum.
RF, radio frequency	Frequencies generally considered to be between 150kHz and 300GHz.
Screening	An alternative term for shielding
Shielding	The use of conducting material to form a barrier to EM waves, so that they are reflected and/or absorbed.
Spike	An alternative term for transient.
Surge	A form of transient, which has a higher energy content, typically produced by the current from a lightning strike coupling into long cables such as power supply or telecommunication cables. A surge has much longer risetimes and decay times associated with it than fast transients.
T	Tesla, a unit of magnetic field strength used for DC and low-frequency fields
Transient	A rapid change of the waveshape of voltage, current, or field, of very short duration followed by a return to steady state.
V	Volts
VDU	Visual Display Unit, a computer monitor
VLSI, Very Large Scale Integration	A dense and complex IC, such as a memory, microprocessor or DSP.
V/m	Volts/metre, a unit of electric field strength
W	Watts

Indexes for the first 873 EMI Stories

Indexed by type of application

Aids for the disabled: wheelchairs, hearing aids, audio induction loops

11, 92, 96, 219, 220, 239, 445, 454, 492, 494, 514, 583, 636, 798, 807

Alternative power generation (e.g. PhotoVoltaic) and active infeed converters (AICs)

633, 696, 726, 727, 860

Amateur Radio

30, 210, 274, 276, 348, 351, 457, 493, 596, 646, 818, 836, 867

Animal migrations

856

Broadband over power lines (also known as Power Line Communications, PLC, or Power Line Telecommunications, PLT)

208, 272, 343, 549, 616, 732, 786, 818

Cable TV (CATV)

85, 135, 826

Computers, PCs, laptops, PDAs, servers, monitors, office equipment, business machines, information technology equipment (ITE), photocopiers, data centres, wired datacomms (Ethernet, USB, CAN, HDMI, etc.) etc.

2, 4, 10, 13, 14, 18, 34, 46, 48, 62, 64, 89, 94, 101, 133, 140, 146, 154, 161, 173, 189, 199, 202, 203, 206, 243, 274, 278, 309, 310, 337, 338, 339, 401, 431, 443, 451, 457, 460, 479, 487, 497, 545, 551, 571, 572, 645, 665, 742, 750, 758, 759, 806, 821, 833, 852, 862, 872, 873

Consumer electronics (Hi-Fi, Radio, TV, CD, DVD, MP3, wristwatches, cameras, games, etc.)

28, 31, 32, 33, 58, 68, 69, 76, 77, 81, 132, 143, 153, 160, 171, 180, 189, 203, 222, 236, 237, 238, 265, 274, 285, 286, 302, 322, 330, 344, 353, 355, 360, 363, 364, 379, 389, 399, 422, 428, 443, 471, 484, 488, 493. 511, 513, 528, 529, 538, 548, 550, 552, 556, 558, 561, 579, 580, 610, 659, 667, 672, 675, 682, 683, 689, 713, 714, 726, 730, 731, 742, 747, 755, 777, 778, 780, 808, 825, 834, 840, 846, 849, 872, 873

Detailed design issues: hardware/circuits, software, filters, shields, cables, printed-circuit-boards (PCBs), etc.

150, 156, 205, 206, 525, 567, 583, 584, 585, 586, 587, 588, 591, 592, 594, 598, 599, 602, 609, 645, 657, 663, 664, 666, 696, 776, 777, 778, 784, 792, 814, 847, 866, 873

Elevators and lifts, moving stairways, pavements, etc.

401, 402, 403, 410, 542, 571

EMC compliance, standards and Regulations

48, 64, 76, 103, 109, 147, 199, 206, 283, 286, 309, 361, 408, 437, 485, 503, 505, 515, 516, 537, 559, 560, 614, 615, 616, 617, 630, 633, 667, 675, 683, 708, 726, 754, 755, 759, 777, 780, 795, 805, 806, 819, 841, 842, 843, 844

Emergency Services (Police, Fire, Ambulance, paramedics, search & rescue, etc.)

3, 39, 121, 122, 123, 179, 321, 325, 330, 342, 353, 385, 409, 414, 432, 434, 534, 547

Entertainment, sport, exercise, restaurants, pubs, professional audio, video and lighting

12, 39, 61, 71, 105, 106, 172, 205, 337, 372, 413, 434, 438, 454, 484, 489, 540, 589, 600, 641, 686, 692, 745, 793, 864

Financial or cost issues

49, 50, 51, 52, 73, 89, 101, 120, 133, 147, 151, 156, 167, 170, 176, 177, 178, 191, 192, 239, 280, 284, 286, 309, 346, 352, 361, 362, 371, 372, 421, 433, 437, 448, 490, 515, 516, 522, 530, 531, 536, 590, 591, 614, 618, 655, 658, 660, 740, 742, 752, 813, 838

(Note: GPS EMI Issues are not included here, although it is used to generate accurate time clocks for control of financial transactions and so is arguably very important for the finance industry. See the entry on Global Navigation Space Systems, below)

Global navigation space systems (GNSS) e.g. GPS, Galileo

29, 98, 119, 134, 207, 222, 223, 224, 227, 228, 229, 230, 231, 232, 238, 278, 291, 357, 363, 371, 388, 415, 420, 491, 623, 625, 626, 647, 653, 668, 692, 698, 719, 720, 762, 782, 804

High Voltage (HV) electrical power distribution

87, 88, 114, 426, 448, 536, 548, 607, 623, 624, 632, 638, 639, 650, 748, 753, 801, 843

Household (domestic, residential) appliances, garage door openers, fire detectors, burglar alarms, smoke detectors, etc.

2, 4, 8, 19, 30, 31, 35, 40, 56, 77, 79, 142, 148, 182, 190, 202, 203, 213, 274, 307, 308, 310, 312, 322, 349, 355, 360, 374, 385, 390, 391, 404, 414, 416, 444, 464, 493, 498, 502, 513, 517, 528, 535, 538, 539, 674, 694, 760, 767, 788, 789, 797, 815, 863

CHERRY CLOUGH CONSULTANTS LTD

Industrial and process control, machinery, robotics

18, 24, 25, 27, 37, 43, 45, 47, 48, 51, 52, 53, 82, 103, 108, 118, 120, 141, 163, 164, 165, 168, 169, 215, 279, 340, 407, 417, 425, 431, 433, 440, 441, 442, 483, 485, 499, 512, 595, 602, 604, 618, 642, 655, 693, 707, 736, 739, 820, 835, 857, 859

Instrumentation and measurement equipment, inc. scientific

48, 59, 156, 165, 169, 210, 248, 249, 278, 284, 287, 338, 425, 619, 708, 709, 770, 803, 851

Intelligent ('smart') buildings, access control, security, HVAC, etc.

144, 399

Intentional electromagnetic interference (IEMI) including for criminal purposes, EM weapons, EM 'bombs', EM pulse 'guns', EM pulse, HEMP, Information Warfare, Jammers, etc.

14, 29, 91, 145, 184, 207, 212, 224, 227, 232, 321, 448, 508, 607, 608, 624, 635, 648, 668, 704, 725, 756, 782, 804, 829, 838, 839

Integrated Circuits and semiconductors themselves

861

Lamps, luminaires and lighting

19, 40, 58, 81, 86, 101, 102, 158, 159, 171, 198, 219, 271, 274, 344, 374, 386, 431, 438, 569, 579, 597, 628, 659, 672, 714, 715, 716, 734, 738, 754, 761, 780, 789, 796, 815, 817, 834, 836, 870

Medical, healthcare

3, 16, 20, 26, 38, 55, 65, 66, 67, 72, 80, 83, 121, 124, 129, 137, 156, 174, 175, 197, 219, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 332, 338, 345, 347, 377, 387, 418, 422, 423, 432, 435, 436, 446, 449, 450, 451, 452, 453, 459, 470, 471, 481, 501, 505, 506, 520, 541, 573, 574, 575, 576, 577, 578, 706, 709, 711, 712, 715, 723, 724, 731, 740, 741, 761, 764, 787, 789, 791, 823, 828, 832, 837

Military, weapons, and security (both personal and national)

6, 14, 56, 91, 99, 125, 139, 145, 181, 224, 227, 235, 240, 243, 269, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 301, 318, 348, 368, 427, 449, 463, 466, 477, 492, 495, 507, 519, 551, 582, 593, 598, 608, 627, 629, 695, 701, 725, 750, 779, 797, 802, 836, 854, 868

Mobile radio transmitters and receivers:

Hand-helds, including: cellphones, walkie-talkies, cordless phones, DECT, CB radio, pagers, RFID, Machine-to-machine (M2M), etc.

26, 33, 34, 38, 54, 65, 70, 74, 78, 84, 86, 92, 93, 95, 96, 107, 108, 112, 113, 121, 122, 123, 124, 126, 148, 169, 170, 173, 175, 179, 187, 193, 197, 201, 204, 214, 219, 237, 252, 255, 273, 277, 281, 285, 302, 395, 306, 326, 347, 350, 357, 363, 375, 377, 378, 383, 387, 402, 419, 423, 429, 430, 435, 436, 446, 450, 451, 452, 453, 462, 470, 472, 482, 490, 501, 507, 524, 529, 561, 564, 573, 574, 576, 577, 578, 603, 620, 634, 636, 649, 651, 661, 676, 678, 684, 693, 702, 706, 708, 709, 710, 711, 712, 713, 717, 719, 723, 740, 759, 762, 768, 781, 789, 798, 806, 807, 809, 810, 812, 819, 825, 826, 828, 837

Vehicle-mounted radio transmitters (e.g. taxicabs, police, ambulance, fire tenders, cars, trucks, aircraft, boats and ships, etc.)

3, 32, 93, 110, 111, 116, 130, 278, 285, 288, 289, 291, 331, 411, 429, 478, 479, 676

Basestations for the above

250, 320, 351, 367, 403, 446, 469, 534, 612, 676, 729, 794, 817

Oil, gas, coal – extraction (e.g. mining) and refining

17, 117, 214, 431, 526, 618, 691, 812, 855, 858

Power control (e.g. thyristors, triacs) and power conversion

162, 164, 165, 166, 866

Power generation and distribution, including portable and standby generation, AC and DC

44, 55, 116, 161, 354, 396, 418, 522, 603, 639, 651, 661, 691, 822, 867

Radar (military, marine, weather, etc.)

63, 181, 240, 241, 289, 292, 313, 356, 381, 382, 394, 424, 427, 466, 518, 535, 572, 589, 677, 695, 758, 832

Radio Astronomy

272, 343, 728, 773

Radiocommunications, including broadcasting (TV and radio): shortwave; AM; FM; VHF; UHF; microwave, satellite, etc. (Note: mobile radiocomm's has a separate entry)

5, 20, 28, 34, 60, 61, 67, 90, 104, 115, 135, 136, 142, 143, 190, 191, 192, 196, 198, 208, 216, 226, 249, 265, 270, 271, 273, 284, 313, 325, 329, 369, 380, 405, 434, 444, 478, 493, 498, 513, 518, 521, 527, 669, 673, 697, 699, 714, 715, 721, 722, 732, 742, 743, 774, 788, 793, 794, 865, 870

Retailing, shops, electronic article surveillance (EAS)

43, 70, 80, 96, 137, 174, 247, 253, 398, 445

Smart meters, smart grid, etc.

703, 726, 732, 786, 805, 869

Switch-mode electronic power converters (e.g. AC-DC, DC-DC, DC-AC, AC-AC, etc.) including PWM and variable speed motor drives (DC and AC) including VFDs ASDs and traction

1, 18, 50, 101, 162, 168, 233, 274, 278, 279, 282, 324, 433, 438, 455, 469, 483, 511, 512, 605, 609, 644, 699, 705, 737, 787, 803, 805

Telecommunications using wires (telephones, modems, fax, ISDN, broadband, xDSL, etc.)

90, 109, 136, 211, 226, 233, 274, 276, 339, 352, 393, 395, 515, 516, 556, 557, 601

Transport (vehicles and infrastructure)

Aircraft, aviation, avionics, airplanes, aerospace, helicopters (rotorcraft), both military and civilian

22, 23, 60, 63, 68, 69, 84, 99, 112, 113, 129, 135, 149, 155, 170, 186, 187, 188, 189, 194, 195, 196, 201, 204, 225, 277, 289, 290, 294, 295, 298, 301, 350, 357, 358, 363, 364, 365, 378, 381, 382, 383, 397, 428, 447, 458, 462, 467, 468, 474, 487, 496, 502, 504, 517, 518, 523, 527, 530, 544, 549, 550, 564, 568, 581, 589, 593, 621, 640, 648, 649, 671, 678, 679, 680, 694, 695, 697, 702, 735, 740, 744, 766, 785, 789, 804, 809, 814, 839, 850, 853, 871

Automobiles, motor cars, motorcycles, scooters, trucks, tractors and buses – internal combustion, hybrid or electric, both military and civilian

9, 15, 35, 54, 57, 58, 93, 97, 110, 111, 125, 129, 130, 144, 152, 170, 180, 183, 184, 217, 235, 265, 273, 283, 284, 304, 305, 306, 313, 320, 321, 324, 331, 356, 359, 366, 373, 376, 381, 382, 385, 386, 394, 411, 412, 416, 429, 430, 431, 456, 459, 465, 466, 480, 482, 521, 524, 525, 532, 534, 546, 553, 562, 563, 596, 598, 606, 610, 612, 621, 637, 677, 682, 710, 717, 718, 740, 757, 758, 765, 772, 783, 824, 845

Ships, boats, other vessels, both military and civilian

36, 74, 75, 213, 222, 223, 240, 269, 278, 318, 348, 354, 472, 473, 690, 691, 716, 775, 782, 813, 831

Railways, subway trains, trams

12, 41, 42, 72, 94, 115, 262, 263, 264, 282, 326, 375, 384, 431, 461, 486, 510, 543, 567, 570, 584, 613, 620, 632, 652, 705, 749, 751, 771, 827, 841, 842, 843, 844, 851, 855

Spacecraft, launch vehicles and satellites, both military and civilian

221, 266, 267, 275, 405, 406, 421, 424, 458, 460, 611, 622, 666, 669, 673, 685, 733, 735, 767, 774, 799, 811, 816, 848

Toys

10, 58, 307

Wireless datacomm's, Wi-Fi, Bluetooth, WLAN, UWB, etc.

119, 131, 132, 244, 245, 260, 327, 390, 391, 392, 409, 412, 451, 467, 504, 555, 564, 585, 595, 631, 654, 681, 687, 747, 749, 756, 795, 844, 850, 871

For every 100th Banana Skin we try to find an amusing or off-beat item.

Indexed as having significant safety implications

(includes GPS EMI because GPS is often relied upon for safety-critical purposes (such as navigation) even though it is unsuitable for this purpose, being too unreliable)

16, 17, 20, 24, 25, 27, 36, 37, 41, 45, 55, 63, 66, 68, 69, 73, 74, 75, 78, 93, 98, 99, 110, 113, 114, 115, 116, 117, 118, 119, 124, 126, 129, 135, 137, 170, 179, 181, 182, 185, 193, 194, 195, 196, 197, 201, 207, 214, 219, 220, 222, 223, 224, 225, 227, 228, 229, 230, 231, 232, 233, 238, 239, 240, 241, 244, 246, 247, 251, 253, 255, 260, 267, 268, 269, 273, 281, 282, 289, 293, 296, 297, 298, 299, 301, 303, 305, 306, 307, 312, 318, 331, 350, 357, 363, 371, 374, 377, 378, 388, 394, 401, 404, 411, 415, 418, 420, 423, 427, 429, 434, 448, 452, 453, 458, 467, 468, 472, 477, 480, 487, 491, 495, 496, 498, 501, 502, 505, 506, 507, 508, 510, 518, 519, 520, 522, 523, 524, 525, 526, 527, 530, 536, 537, 539, 541, 543, 544, 547, 549, 562, 564, 565, 567, 570, 573, 574, 575, 576, 577, 578, 580, 581, 602, 604, 606, 607, 613, 618, 620, 621, 622, 623, 624, 625, 626, 627, 629, 640, 643, 646, 649, 650, 651, 671, 677, 679, 680, 681, 684, 686, 689, 690, 693, 695, 698, 702, 703, 704, 705, 706, 709, 710, 711, 712, 716, 717, 719, 720, 722, 724, 729, 740, 741, 744, 749, 751, 753, 761, 765, 771, 774, 779, 783, 785, 789, 791, 802, 804, 807, 809, 812, 813, 823, 824, 827, 828, 831, 832, 837, 841, 848, 850, 853, 863, 867, 868, 871

Indexed by the type of coupling of electromagnetic disturbance

Power Quality interference (for either AC or DC supplies)

55, 89, 101, 102, 176, 177, 178, 396, 407, 438, 511, 640, 752

Harmonics and interharmonics (currents, and voltage waveform distortion)

1, 7, 59, 104, 354, 417, 455, 522, 597, 600, 618, 632, 660, 699, 831

Dips, dropouts, sags, swells, interruptions, brownouts and blackouts

21, 53, 73, 280, 283, 433, 464, 639, 686, 690, 767, 822, 859

Overvoltages: transients and surges

8, 19, 24, 37, 40, 45, 47, 62, 87, 161, 162, 163, 166, 168, 182, 202, 203, 211, 275, 283, 288, 303, 306, 311, 312, 360, 404, 426, 440, 441, 442, 460, 486, 534, 545, 604, 637, 655, 724, 746, 748, 765, 801, 824, 851

Low frequency (down to DC) magnetic or electric fields

12, 13, 46, 88, 94, 114, 129, 146, 153, 185, 243, 256, 264, 287, 337, 445, 454, 461, 470, 497, 520, 546 (probably), 601, 613, 638, 658 (probably), 791, 856

Radiated RF and spectrum management issues

2, 3, 11, 20, 29, 30, 38, 39, 54, 56, 61, 63, 65, 68, 69, 70, 74, 78, 84, 92, 93, 96, 108, 111, 112, 115, 116, 119, 121, 122, 123, 124, 126, 129, 130, 131, 134, 135, 136, 137, 139, 142, 143, 144, 149, 152, 169, 170, 173, 174, 175, 179, 180, 181, 184, 190, 193, 196, 201, 204, 207, 208, 209, 219, 222, 224, 225, 235, 236, 237, 239, 240, 241, 242, 244, 250, 252, 255, 260, 265, 270, 271, 272, 276, 277, 281, 285, 288, 289, 291, 297, 299, 302, 305, 306, 318, 320, 321, 330, 331, 343, 349, 350, 353, 355, 356, 357, 358, 359, 363, 364, 365, 367, 369, 371, 375, 377, 378, 379, 380, 381, 382, 383, 385, 387, 389, 390, 391, 392, 394, 397, 398, 405, 408, 409, 411, 413, 414, 416, 419, 423, 424, 427, 428, 429, 430, 431, 434, 435, 436, 443, 444, 446, 447, 449, 450, 451, 452, 453, 456, 459, 462, 465, 467, 468, 469, 470, 472, 478, 479, 480, 481, 484, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 498, 499, 501, 502, 503, 504, 507, 513, 517, 518, 519, 521, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 540, 547, 548, 549, 550, 551, 552, 553, 555, 558, 560, 561, 562, 563, 564, 568, 569, 572, 573, 574, 576, 577, 578, 593, 595, 596, 603, 605, 606, 608, 610, 611, 612, 617, 625, 626, 631, 634, 636, 641, 644, 645, 647, 651, 654, 659, 661, 668, 672, 673, 674, 675, 676, 678, 679, 680, 681, 682, 683, 685, 687, 689, 693, 695, 697, 698, 702, 706, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 719, 729, 731, 732, 733, 740, 742, 743, 744, 749, 756, 761, 762, 763, 764, 766, 768, 769, 772, 773, 774, 775, 779, 780, 781, 782, 785, 788, 789, 793, 794, 795, 797, 798, 802, 806, 807, 809, 812, 818, 823, 825, 826, 828, 829, 834, 837, 838, 839, 840, 844, 845, 847, 848, 849, 850, 853, 854, 855, 857, 862, 863, 864, 865, 867, 870, 871, 872, 873

Conducted RF on power or signal cables, or other conductors, transient or continuous

41, 117, 118, 141, 165, 211, 215, 262, 283, 288, 340, 342, 352, 426, 505, 506, 512, 514, 515, 516, 517, 542, 551, 556, 557, 567. 571, 582, 584, 609, 615, 616, 633, 667, 691, 696, 701, 705, 726, 727, 730, 734, 736, 738, 739, 747, 751, 778, 786, 787, 796, 803, 805, 814, 835, 860, 862, 866, 869

Lightning, including LEMP

17, 106, 127, 128, 290, 346, 473, 475, 476, 509, 566, 662, 671, 771, 808, 858

Electromagnetic pulse: EMP, HEMP, NEMP, etc., and other EM weapons

14, 91, 145, 184, 212, 321, 448, 508, 607, 624, 627, 648, 704, 725, 750

Electrostatic discharge (ESD) of all types

22, 23, 129, 138, 154, 170, 194, 195, 206, 275, 293, 294, 295, 296, 298, 319, 366, 410, 417, 432, 458, 474, 580, 590, 591, 642, 665, 707, 770, 799, 810, 821, 852, 861

Solar wind, solar storms, space weather, coronal mass ejections, northern lights, cosmic rays, single-event-upsets (SEUs), geomagnetism, etc.

73, 275, 388, 420, 460, 536, 554, 565, 607, 621, 622, 623, 650, 653, 669, 720, 721, 735, 753, 769, 811, 816, 868