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EMI Stories 381 to 475

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EMI Stories 381 to 475

381) 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.)

382) 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.

In a worst-case scenario these sources might cause damage to the on-board electronic devices.

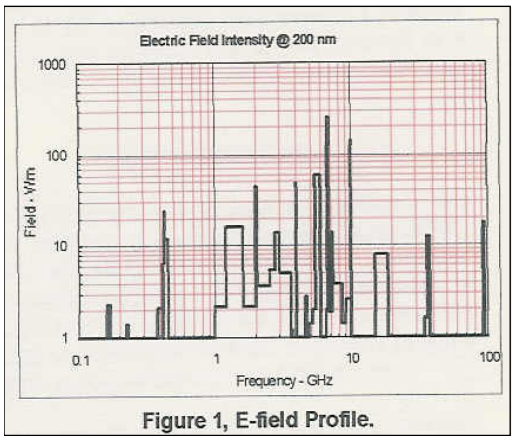

Figure 1, E-field Profile.

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.

(S*ent 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.

(*Submitted 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.)*