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# EMI Stories 191 to 285

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# EMI Stories 191 to 285

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

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

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

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

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

**192) More on the demise of ITV Digital**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**197) Guide on proximity of wireless communications to pacemakers**

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

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

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

**198) Fluorescent lamp interferes strongly with AM and FM radio**

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

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

**199) CE marked keyboard fails ESD tests**

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

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

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

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

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

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

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

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

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

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

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

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

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

**202) Vacuum cleaner interferes with computer terminals**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

*(From Tony Waldron, 8th Jan 02)*

**206) ESD problems with CE-marked keypads and mouses**

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

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

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

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

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

**207) Interference and jamming threats to GPS**

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

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

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

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

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

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

**208) Broadband over power lines – interference concerns**

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

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

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

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

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

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

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

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

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

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

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

**209) Increasing pollution of electromagnetic environments**

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

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

**210) Examples of interference from Douglas Brooks**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**212) Concerns about threats from electromagnetic pulse weapons**

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

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

**213) Kitchen equipment interferes with passenger ferry logging system**

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

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

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

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

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

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

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

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

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

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

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

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

**216) Combating satellite interference**

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

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

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

**217) Electromagnetic fields in cars**

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

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

**218) 'Singing' light bulbs and their interference possibilities**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**221) Examples of interference from NASA**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**223) Unreliability of GPS-based navigation systems**

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

On most modern ships, (D)GPS is the only source of position information to the electronic chart (ECDIS) and to the mandatory onboard transponder of the Automatic Identification System

(AIS). Especially on high-speed craft and on one-man bridges there is little time to cross-check navigation accuracy with other available information, such as radar. False position information to the AIS could even lead to "AIS-assisted collisions".

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**227) GPS is vulnerable to jamming**

The U.S. Department of Defense will use in-theatre jamming of the L1 signal to deny its adversaries the use of GPS. While jamming GPS signals has always been a military option, its use became a necessity following deactivation of Selective Availability. In addition to such military procedures, terrorists might try to jam the GPS signals using easily constructed equipment. GPS signals are also susceptible to unintentional jamming.

The civil GPS community got an eye-opener in 1997 as well. First, the Russian company Aviconversias announced in September that it could deliver a commercial GPS/GLONASS jammer capable of blocking civil GPS receivers within a radius of 200 kilometers. Then military GPS testing in the New York area in December caused a number of GPS receivers in civil aircraft to lose track of GPS signals during approach to Newark International Airport. Thus it was confirmed that civil receivers were vulnerable to jamming, and at the same time, that jamming equipment was commercially available.

One of the most important studies in this field, and – coincidentally – with very good timing (*released one day before the 9/11 attacks on the World Trade Centre – Editor*), was the so-called Volpe report on the vulnerability of GPS which concluded that, like other radionavigation systems, GPS is vulnerable to jamming, and that jamming of GPS could jeopardize safety and have serious environmental and economic consequences. The report also concluded that increased use of GPS in civil infrastructure makes it an increasingly attractive target for hostile activities by individuals, groups and states. At the same time, the analyses underlined the commercial availability of equipment for jamming purposes.

*(Extracts from "*Jamming GPS – Susceptibility of Some Civil GPS Receivers*", by Börje Forssell and Trond Birger Olsen, in GPSworld, January 2003, pages 54 - 58, www.gpsworld.com.)*

**228) Reliability is important for GPS**

In looking to the future, with GPS playing an increasingly important role in our daily lives, we must ensure that we maintain that reliability. With safety and security as its top priorities, the department has developed a 14-point action plan to mitigate any potential vulnerability. We are working closely with the Department of Defense in their GPS modernization efforts, redoubling our efforts to protect critical spectrum resources, and developing capabilities to locate sources of interference quickly.

*(An extract from an article by Jeffrey N. Shane, Associate Deputy Secretary, U.S. Department of Transportation, in "*Directions 2003*" in GPSworld, December 2002, Page 24,*

*www.gpsworld.com. Forgive us for being critical, but it seems to us that the vulnerability of GPS is actual, not potential; and that sources of interference need to be located considerably more quickly than the several months reported in item 222. The reason why this item is included here, is that one of the main causes of unreliability in GPS is electromagnetic interference.)*

**229) GPS signal reception will be more challenging in the future – example of UWB**

The FCC published a rulemaking authorizing unlicensed ultra-wideband (UWB) signal emissions. Many believe these have the potential for interference to GPS and to raise the noise floor.

The GPS signal reception environment will be more challenging in the future – the UWB rulemaking is a bellwether event. There is incredible demand for wireless capability, which will only grow in the future. At the same time, dependence on GPS-based POITIME is increasing in military systems, in "safety-of-life" navigation systems, and in essential transportation, communications, financial, timing and other infrastructures.

*(Extracts from an article by Jim Doherty, Senior Analyst, Institute for Defense Analyses; member, Independent GPS Assessment Team, in "*Directions 2003*" in GPSworld, December 2002, page 26, www.gpsworld.com. Note that the GPS satellite signals are so weak that they are already below the ambient noise floor even in the quietest locations on the earth's surface. Software algorithms are used to make them readable. UWB is bound to be widely adopted because of its low cost. )*

**230) GPS is so vulnerable to EMI that back-up systems are required for safety-of-life applications**

The DOT/Volpe study on the vulnerability of GPS concluded that interference – either intentional or unintentional – could deny GPS access for critical infrastructure applications. It also concluded that, for safety-of-life applications, back-up systems to GPS would have to remain in place. Lacking other qualifiers in the summary text, one assumes that the back-ups are intended to remain in place indefinitely.

*(From an article by Terry McGurn, former senior analyst, Central Intelligence Agency, in "*Directions 2003*" in GPSworld, December 2002, page 33, www.gpsworld.com. The "Volpe" report can be downloaded via http://www.navcen.uscg.gov/gps/geninfo/pressrelease.htm or direct from http://www.navcen.uscg.gov/archive/2001/Oct/FinalReport-v4.6.pdf.)*

**231) Vulnerability of GPS and Galileo and likelihood of jamming**

The perception of the vulnerability of satellite navigation signals by both Europe and the United States seems to have changed 180 degree over the last ten years. In the 1990s, Europe was cautious about transitioning to GPS aviation landing systems, and it was Europe that pushed for the introduction of microwave landing systems (MLS) as a replacement for instrument landing systems (ILS). The key reason stated was the weakness of the signal delivered from space. The U.S. on the other hand, championed the benefits of GPS and declared that by the end of the 1990s, Wide Area Augmentation System (WAAS) and Local Area Augmentation System (LAAS) would be operational and ILS (and other navaids) a technology of the past.

Over the last year the U.S. has acknowledges that GPS is a vulnerable system, particularly to intentional and nonintentional interference, and has concluded that backup systems and techniques to find intentional interference will be required for critical infrastructure. On the other hand, Europe seems unworried by the situation and declares that Galileo (which will use the same technology as GPS) has a very good backup – called GPS.

Some also believe that the applications suggested for Galileo, such as road tolling, will promote widespread jamming by the public – with major implications for other users.

*(Extracts from an article by Alan Shuster Bruce, Manager GNSS Programs, Thales Avionics UK, in GPSworld, December 2002, pages 33 and 34, www.gpsworld.com.)*

**232) Many common sources can interfere with GPS, and jammers are easy to make**

Just recently, the U.S Coast Guard and FCC confirmed that certain consumer VHF/UHF marine television antennas cause inaccurate position information or a complete loss of GPS receiver acquisition and tracking ability. On a broader scale, the FAA has acknowledged interference sources to be commercial and civilian aviation such as broadcast television, personal electronic devices, Mobile Satellite Service (MSS) communications systems, and ultra-wideband (UWB) radar and communication systems. The busier the airwaves become, the more susceptible GPS is to interference.

With electronics schematics obtained from the internet, you can go to an electronics supply store, spend about $500 and get the parts you need to build a GPS jammer that can disable the commercial use of GPS out to 100 to 125 kilometers – line of sight.

One long-term solution would be to increase satellite signal power. But those large improvements are not scheduled for another 10 years! You can now use an appliqué or antenna and electronics add-on package which removes the interference before it gets to the GPS receiver. This is what ERI provides.

*(Extracts from an 'advertorial' by Mario M. Casabona, President and CEO of Electro-Radiation Inc. (ERI), in "Showcase" in GPSworld December 2002, page 21, www.gspworld.com.)*

**233) Ensembles of sources will make interference problems harder to solve**

ADSL and VDSL (broadband internet over ordinary telephone wires), low voltage lighting using 'transformerless' power supplies, plug-top switch-mode power supplies, variable-speed motor drives used in domestic appliances to save energy, power line telecommunications (PLT, also called PLC), ultra-wideband (UWB) radar and radiocommunications – are examples of the kinds of 'noisy' low-cost electronic devices and systems likely to enjoy wide adoption over the next few years.

If present trends continue (as they seem likely to) – in the not-so-distant future interference with radio communications (including safety-critical avionics systems) will no longer be identifiable or preventable as it will arise from 'ensembles' of many thousands of such cheap and cheerful interference sources, even if they all actually complied with the relevant emissions standards prevailing at the time they were taken into service and none are faulty (which is an unlikely situation in any case).

*(From "*Future Trends in EMC*" presented by Keith Armstrong of Cherry Clough Consultants at the Flomerics seminar "Introduction to EMC" in Taipei, Taiwan, September 17 - 18 2002, www.flomerics.com.)*

**234) The EM environment is worsening whilst vulnerability to EMI is decreasing**

The environment in which we live is becoming richer with man-made electromagnetic energy and at the same time the susceptibility threshold of electronic technology is decreasing.

*(From Maqsood Mohd, Chairman of the IEEE EMC Society Education and Student Activities Committee (EASC), writing in the IEEE EMC Society Newsletter, January 2003, www.ewh.ieee.org/soc/emcs.)*

**235) Military base security upgrades interfere with car immobilisers and alarms**

President Bush's son of star wars has neutralised its first targets in Yorkshire even before the British government has given the formal go-ahead for the RAF Fylingdales base on the moors to be used for the project. The upgrading of the security and surveillance systems at the base, in preparation for an onslaught of peace protesters objecting to the scheme, is knocking out the electrical systems of expensive cars.

Visitors to the beauty spot of Goathland, where the TV series Heartbeat is filmed to portray an idyllic 1960s rural life, have found themselves trapped among its charms. High power radar pulses trigger the immobilising devices of many makes of cars and motorcycles - BMW, Mercedes and Jeep among them. Many have had to be towed out of range of the base before they can be restarted.

The RAF admits it is a problem but says it is down to the car manufacturers to change their frequencies. However, Jeep claims this is not possible because of government restrictions.

Either way the locals are not amused. Frank Doyle, who owns a shop called Bazaar in Whitby, makes regular deliveries to the Goathland area in his Mercedes Vito van. He said: "I have got stuck three times in less than two weeks and have to keep calling breakdown services to get out of the place. "I am very fed up with it. It's not just the inconvenience - it messes up the business and my social life. Now when I'm on deliveries I keep the engine running, but still can't visit friends who live near Fylingdales."

Goathland resident Jackie Fearnley said: "I know that car alarms do go off, but this is getting ridiculous. It is disturbing all the villagers - and I don't think it is going to help tourism here either. Someone has got to sort this out."

North York Moors National Park car park attendant Bill Peirson said that Jeep Cherokees, Mercedes cars and vans, and BMWs seemed to be worst affected by the radar. "As soon as the alarms go off, I go over to the owners and explain it's probably the Fylingdales radar that's caused it.

"Motorbikes are the worst. There was a bike alarm screaming all afternoon recently and the rider didn't have any breakdown cover. I asked a friend in the village with a trailer to tow him away, and as soon as they were out of Fylingdales' range, it stopped."

Wing Commander Chris Knapman, of RAF Fylingdales, said it was not up to the base to resolve the problem. "We have had the frequencies we use for a very long time," he said. "They are allocated to commercial, military and government users, and the allocation is very tightly controlled. As far as we are concerned, the radars are working on frequencies which are well known, and most car manufacturers take that into account."

A spokesman for Jeep said: "The problem is that the government gives manufacturers such a narrow band to operate in - so the radio wave we use for our key fob is severely restricted."

*(From "*Son of star wars leaves drivers stranded*" by Paul Brown and Nigel Burnham, Wednesday December 18 2002, The Guardian Copyright, Guardian Newspapers Limited. Mike Feeney of Freeman Hospital, Newcastle on Tyne, spotted this on the Guardian Unlimited site. To see this story with its related links, go to http://www.guardian.co.uk.)*

**236) TV antenna boosters interfere with specialised mobile radio systems**

These devices *(active television antenna profiled in January 2003 GPS World article)* can also interfere with specialized mobile radio (SMR) systems. We have a cell site near Mission Bay in San Diego. A few months ago we started getting interference on several of the channels in this site. The interference was centred around 815MHz and was about 2MHz wide.

Two days of sniffing it out with a spectrum analyzer was required. The boat owner was on an extended trip but allowed us to disconnect the offending antenna.

*(Rich Reinhofer, Supervisor RF Operations, Nextel, San Diego, writing in GPS World, March 2003, page 8, www.gpsworld.com. The article he is referring to was summarised in Banana Skins No. 222.)*

**237) TV antenna boosters interfere with cell phone systems**

I've also been involved in hunting down interference caused by active television antennas. In my case, the interference was to a cellular telephone system and the TV antennas were mounted atop RVs *(Recreational Vehicles – Editor)* at mobile home parks. The unit(s) causing interference were in some cases more than two miles from the cellular phone site that was receiving interference.

If what you were tracking *(see Banana Skin 222 – Editor)* was the second harmonic of the signal from the oscillating amplifier, the signal only has to drift a small amount for the fundamental signal to cause interference to the base station receivers of cellular telephone, public safety, and business radio systems operating in the 806-849 MHz band.

IS-95 CDMA cellular telephone systems are extremely sensitive to this type of interference. In my company's case, finding the offending devices and getting them turned off is worth a nearly unlimited effort.

*Author's reply:* The emissions from the antenna we studied in detail had a fundamental frequency near 1575 MHz. This was not a harmonic. Its precise frequency depended upon temperature and other environmental variables. The other two antennas also had temperature-dependant frequencies near to the GPS L1 frequency, but we did not study them in a laboratory environment. We do not know that this was the fundamental frequency for the other two RFI sources, but that is likely. *Jim Clynch*

*(Eric Lawson, Senior Engineer, Alltel Communications, writing in GPS World, March 2003, with reply, Page 8, www.gpsworld.com. Note that in the USA all the personal cellphones operate around 1.9GHz, but they have a number of other specialised cell-based telecommunication networks operating in the 800-850 MHz region, including a country-wide system for use by police and other emergency services, see Banana Skin No 179.)*

**238) TV antenna boosters causing interference to GPS etc. identified by US Coast Guard**

We are currently *looking* at numerous applications for GPS on board locomotives. I was quite interested in the recent article "The Hunt for RFI" but was quite disappointed that it did not list the model or manufacturer's name of the offending pre-amplifiers as we may want to put out a bulletin to determine if any of these devices are installed in our railroad yards or office cars. Is this information available? *(Gary G Wilson, RF Systems Engineer)*

I have been involved with tracking similar problems with interference to radio systems here in Indianapolis, Indiana area. The cause of the interference has been traced to defective manufactured RV television antennas. The article did not mention the manufacturer of the antenna. Could you pass along my query about the manufacturer? *(Bill Atkin)*

Names of the equipment jamming GPS were not published in the January article for liability reasons. The U.S. Coast Guard now has a safety notice at www.uscg.mil/hq/gm/moa/docs/11-02.htm, listing brands and model numbers of known emitters. You can reach this site via www.navcen.uscg.gov by going to GPS, Notes, and Information. The list may not be complete, however. The model traced by Bill Atkin is not on it. The FCC tracked the preamplifiers in three jamming antennas to an overseas factory owned by a subsidiary of a U.S. company. It is believed that the bad units began with a design change in late 2000. The number of units sold is not known, but they went to at least five different companies producing consumer goods.

(*Two letters published in GPS World, March 2003, page 8, with a reply from that publication's editor, www.gpsworld.com. See Banana Skin 222 for the article that began this correspondence. Another site for the US Coast Guard report used to be: www.ccg-gcc.gc.ca/mcts-sctm/GPSinterference-e.doc.)*

**239) Complying with immunity standards might not defend against product liability lawsuits**

The following *jurisprudence* shows how negligence can be interpreted. In the Netherlands a recent lawsuit came up about a wheelchair. This chair unintentionally drove off a subway-platform. The driver was badly injured and her insurance company started an investigation with help of an EMC laboratory. They found out that the chair was activated by a field of only a few Volts/meter at a frequency of 1.89 GHz.

The manufacturer of the chair did not accept his responsibility by arguing that his chair did meet the relevant product standard for wheelchairs. The radiated susceptibility test in this standard however did not go beyond 1 GHz. The judge decided that the manufacturer could have known that 1.89 GHz was a commonly applied frequency for the digital telephone network.

The manufacturer was sentenced because he had put an unsafe product on the market. It should be noted that this example is about Product Liability and not about EMC. We also learn from this case that the application of a standard is not a guarantee for being safeguarded from lawsuits.

*(From Dick Groot Boerle, Teamleader EMC Laboratory for Thales Nederland B.V., from his paper "*EMC and Functional Safety, Impact of IEC 61000-1-2*", the IEEE International EMC Symposium, Minneapolis, August 2002.)*

**240) HMS Sheffield disaster caused by lack of EMC**

Electromagnetic effects can cause impressive disasters that urge us to control the problem. One example is the catastrophe with H.M.S. Sheffield during the Falkland crisis. An Exocet missile hit this frigate because its search radar was switched *off (preventing its anti-missile weapons from being used – Editor)* It was switched off because it was known that the satellite communication system was interfered with by this radar.

At the time of the disaster some officers used this communication link to talk with their prime minister…..The 'disaster philosophy' is already known to many EMC-engineers who every now and then make use of a disaster to get new budgets.

*(From Dick Groot Boerle, Teamleader EMC Laboratory for Thales Nederland B.V., from his paper "*EMC and Functional Safety, Impact of IEC 61000-1-2*", the IEEE International EMC Symposium, Minneapolis, August 2002.)*

**241) X-band radar interfered with ship steering in Rotterdam**

The case in the Rotterdam harbour is an 'old case' of about 15 years ago: we have installed X-band (1 kW) radars for Vessel Traffic Control and due to one of these transmitters the steering machine of a small towing ship was influenced in such a way that the ship hit the quay.

*(From Dick Groot Boerle, private correspondence with Editor, June 2002.)*

**242) Intense DC magnetic fields from superconducting magnets**

In the late 1960s and *early* 1970s the International Research and Development Company Ltd (IRD) of Newcastle upon Tyne were engaged in the building of prototype superconducting DC machines. These were of the homopolar type, in which a conducting disc armature with brushes near the shaft and at the perimeter rotates in the axial field with a maximum field strength of several Tesla produced by a large superconducting coil.

The field coil had to be cooled to 4.2 degrees Kelvin and one of the most difficult aspects of the design was to minimise heat conduction to the coil via the current leads. The solution was to weld a long tube to the top of the cryostat through which long current leads were taken and to suspend the coil from the top of the tube by means of thin high tensile wires in a bifilar suspension. The coil was in essence freely hanging. Now in a normal DC machine there will be a torque reaction on the field winding structure when delivering power, but a feature of the disc type homopolar machine is that the conductors feeding current to and from the armature brushes take the reaction and not the field coil.

Thus it was that the 50 HP prototype with its freely suspended field coil was tested in the laboratory satisfactorily. IRD then scaled up the 50 HP motor to a 3.25 MW boiler feedpump motor that, after much tribulation, was finally installed at Fawley Power Station. The great moment came when the refrigeration systems were finally working and after about a week the coil resistance had reached zero. The field power supply was gradually switched on and then suddenly there was an almighty clunk as the massive field coil in its wrapping of mylar superinsulation banged against the cryostat walls. This was not supposed to happen and the structure was not designed for this eventuality!

What everyone had forgotten was that there would be massive amounts of steel in a power station and it was to this steel that the energised coil was attracted. Much time was then spent positioning additional steel masses in appropriate positions around the power station to neutralise the attractive forces. These masses had to be strongly bolted down, otherwise they would have taken off and crashed into the cryostat.

*(From Dr Antony Anderson, private correspondence with Editor, 25 Oct 03,www.antony-anderson.com.)*

**243) Wireless keyboards crosstalk**

Two Norwegian computer users have found that wireless keyboards may be a security risk, after they accidentally transmitted their typed words to each other's computers 150 metres away.

*("60 Seconds Technology", page 6 of New Scientist 16 Nov 2002, www.newscientist.com.)*

**Pros and Cons of using wireless information technology in hospitals**

Since the 1960s, there have been reports [1] that electromagnetic interference (EMI) can cause critical-care medical devices to malfunction. Such malfunctions have caused inappropriate therapy, patient injury, mortality, or have had the potential to do so. Fortunately, such incidents are rare, and the incidence of such malfunctions appears to be declining with time. However, vigilance is still required because (1) the electromagnetic compatibility (EMC) of many new radio-frequency (RF) sources and new medical devices being introduced into healthcare is unknown, and (2) there will be a substantial increase in usage of wireless information technology needed by healthcare but the EMC of such technology is unknown.

The latter need has been highlighted by reports that perhaps 1 out of every 200 patients admitted to US hospitals die due to medical errors, an annual rate exceeding that due to automobile accidents or due to heart disease. In the vast majority of cases, excellent physicians and medical staff make such errors because they do not have access to appropriate information (e.g., medication errors; current information unavailable). At least some of these deaths would be preventable if wireless information technology were widely used. However, the associated increased RF emissions may cause increased medical-device malfunctions.

(*Taken from: "*Risk of patient injury due to electromagnetic interference malfunctions: Estimation and minimization*" by B.Segal et al, IEEE International EMC Symposium, Montreal, August 13-17 2001, page 1308 in the Symposium Record.*)

**244) Interference potential in hospitals requires comprehensive EMI strategies**

Whilst the number of EMI-related incidents documented during the 1990s was quite small, government statistics do establish that patient morbidity and mortality did result from the ensuing electromagnetic interference from EMES (electromagnetic energy sources) and medical devices, including medical device to medical device interference.

It is submitted that the new millennium will pose greater EMI challenges for healthcare professionals due to two emerging phenomena. The first is the integration of wireless technology into many medical devices for monitoring control and intercommunication purposes. Thus with the addition of digital and wireless technologies, many therapeutic devices will have tripartite functionality. The second important phenomenon will be the integration of wireless technology into the physical infrastructure of hospitals (smart building concepts) for monitoring, control, tracking, record-keeping and intercommunication (of equipment and personnel purposes).

At present, a small number of hospitals are integrating the operation of the cellular telephones of their healthcare staff into the hospital PBX system, but 'digital hospitals' concepts are emerging which will integrate which will integrate fully both wireline and wireless communications into the physical infrastructure of the healthcare facility. Obviously, these phenomena have the potential to increase the ambient level of electromagnetic energy within hospitals and they call for comprehensive EMI strategies.

(*Taken from: "*Risk analysis and EMI Risk Abatement Strategies for Hospitals: Scientific and Legal Approaches*" by David A Townsend, Faculty of Law, University of New Brunswick, Canada, IEEE International EMC Symposium, Montreal, August 132-17 2001, page 1304 in the Symposium Record.)*

**245) FDA records over 500 incidents of interference with cardiac pacemakers**

FDA has evaluated reports of medical device malfunctions caused by electromagnetic interference (EMI), performed device testing, and developed standardized test procedures. Over 500 incident reports are suspected to be attributable to EMI affecting cardiac pacemakers. More than 80 of these reports involve cardiac and other medical device interactions with electronic security systems.

EMI presents a risk to patient safety and medical device effectiveness that is likely to continue as the use of electromagnetic energy in the medical device environment increases (e.g. cell phones, security systems).

(*Taken from: "*Medical Device EMI: FDA Analysis of Incident Reports, and Recent Concerns for Security Systems and Wireless Medical Telemetry*" by Donald Witters et al, of the Center for Devices and Radiological Health (CDRH), Food and Drug Administration (FDA) Rockville, USA, IEEE International EMC Symposium, Montreal, August 13-17 2001, page 1289 in the Symposium Record.)*

**246) Experiences of interference with medical devices in Canada**

Electromagnetic interference (EMI) has been responsible for many medical device malfunctions, raising concerns about the safety of patients who depend on these devices. However, the incidence of unreported EMI malfunctions is unknown. Between 1984 and 2000, Health Canada's Medical Devices Bureau received thirty-six reports of medical device malfunction attributed to EMI. These included 4 reports of medical device malfunctions caused by wireless cellular phones, two cases of EMI interference from electronic article surveillance (EAS) systems on implantable cardiac pacemakers and possibly one case of premature failure of a pacemaker.

The Bureau also investigated reports of interference from other radiofrequency sources. These included (1) Interference of an electrosurgical device with the electrocardiogram signals displayed on the monitor of an automated defibrillator; (2) Complete inhibition of the pacing signal of a pacemaker by a pulsating magnetic field from a video display terminal; (3) Failure of the R-wave detection circuitry of a cardiac defibrillator in the presence of a simulated muscle artifact signal from an electrocardiogram simulator; and (4) Interference of the line isolation system in an intensive care unit with the performance of a defibrillator. These reports highlighted the need for guidelines on the management of EMI within hospitals, especially in critical-care areas.

(T*aken from: "*Electromagnetic Interference in Medical Devices: Health Canada's Past and Current Perspectives and Activities*" by Kok-Swang Tan et al, Medical Devices Bureau, Therapeutic Products Directorate, Health Canada, IEEE International EMC Symposium, Montreal, August 13-17 2001, page 1283 in the Symposium Record.)*

**247) Electrosurgical equipment interferes with endoscope video monitor during operation**

The problem — electromagnetic interference (EMI) from electrosurgery units transmitting noise onto real-time video images from an endoscope being used during the operation.

(*Taken from: "*Electromagnetic Interference (EMI) in an Operating Theatre Environment*", Nigel Beaumont-Rydings, Royal Oldham Hospital, meeting of the "CE North West" club, 30th March 1998.*)

**248) Some experiences with interference to medical devices**

Steve Juett provided the first "War Story" on the EMC challenges facing biomedical instrumentation in hospitals. He presented very straightforward slides illustrating the situation. The FDA has no immunity requirements for biomedical instrumentation. Not surprisingly, the myriad of telemetry links and proliferation of personal computing devices and cellphones present challenges to medical equipment used to save lives, the sensitivities of which can be in microvolts!

Finally, Steve Juett provided another story from the biomedical arena – tracing down the source of an interference problem at the hospital to a local TV station trying out its HDTV band. It took some effort to get in touch with the right individual at the TV station to resolve the problem!

(*Taken from a report on the May 2001 meeting of the IEEE EMC Society Dallas USA Chapter, in the IEEE EMC Society Newsletter Issue 92, pages 8-9. Steve Juett is the Director of Biomedical Engineering at Baylor Hospital in Dallas.*)

**249) Cellphone basestation interferes with hospital**

I do a lot of work with shielding for MRI scanners. RF interference can ruin the images, which are time-consuming and expensive so all MRI scanners are installed in rooms with some degree of shielding.

One hospital I visited to trace an interference problem was the quickest job I ever had. The hospital had “Switch off your cellphone” warning signs all over it – and a plainly visible cellphone basestation on its roof. When they got the basestation switched off, their interference problems ceased.

(*Gary Fenical of Laird Technologies, www.lairdtech.com, private conversation with Editor, 23rd May 2002.*)

**250) More examples of interference with medical devices**

A number of medical interference incidents listed in The “1998 EMC Encyclopaedia” from Emf-Emi Control, Inc…..

- Apnoea monitors susceptible to FM transmissions: The US FDA has reported cases where susceptible apnoea monitors used to monitor the breathing of newborns during sleep have been affected by EMI from RF broadcast sources. The apnoea monitor is designed to alarm when the newborn stop breathing. External interference has been demonstrated to mimic the rhythmic breathing patterns when the interference modulation is demodulated by an audio rectification mechanism. The effect is to fool the apnoea monitor and not alarm properly.
- Patient monitoring system picked up EMI causing alarms not to sound. Two patients died when system failed to detect arrhythmia.
- Paramedics could not sense heart rhythm due to excessive artifacts on CRT monitor. Patient not resuscitated.
- External defibrillator/pacemaker stopped pacing when ambulance attendant used hand-held transmitter too close to patient.
- Battery charger cycling at 1-Hz rate in respiration monitor, coupled to respiration circuit. Patient died with no alarm.
- Intro-Aortic balloon pump stopped pumping when system printer was turned on.
- Pacemaker ceased function during ambulance radio transmission.
- Ventilator - cessation of ventilation, inoperative monitoring, error messages.
- ESD Disabled apnoea monitors without activating an alarm.
- Radiation therapy device - ESD caused source to turn on, display to blank, unintended gantry movement, timer failures.
- Severe interference with heart rate and graphs of ICU patient monitor when blood-pressure monitor in use.
- Infusion pump caused interference with patient monitors.
- Movement of chiropractic table caused by muscle stimulator.
- Microsurgical drill began to run when electrosurgery unit was activated.
- Erroneous displays and latch-up of anaesthesia gas monitor during electrosurgery.
- Intro-Aortic balloon pump stopped pumping when system printer was turned on.
- Neonatal monitors were interfered with when placed close to similar models.
- Respiration rate controller ceased to function when oxygen analyzer was placed on top.
- Cellular phones interfered with incubators, infusion pumps, dialysis equipment, defibrillators. They are banned from some hospitals in Europe.
- Reading of invasive blood pressure monitors jumped 3 to 10 mm Hg when paging transmitter on hospital roof was activated.
- Displays of telemetry patient monitor would “flat-line” when paging company transmitted digital control information to remote sites.
- ECG monitor in defibrillator was interfered with when emergency crew transmitted with antenna inside station wagon with defibrillator.

- Pulse oximeter displayed saturation of 100% and pulse rate of 60 on a patient who had expired. Telemetry transceiver, part of the system, too close to oximeter.

**251) Guidance on use of wireless handsets in hospitals**

*TETRA:* The risk to medical devices from the use of TETRA handsets is comparable to that from GSM cellular phones. All personnel using TETRA handsets on hospital premises should therefore be made aware of, and follow, the local policy guidelines applicable for cellular phone systems. In the case of emergency services dealing with an on site incident, the risk of interference should be treated as secondary to the risks associated with managing the incident. Staff responsible for Trust radio communication policy should liase with local representatives of the emergency services to agree and formulate local working practices.

*Outside Media Broadcasts:* Ensure that a hospital representative such as the Risk, Safety Communications Manager is available to assist Media personnel with the location and operation of equipment. Media personnel using radio handsets (radio-talkback system) on hospital premises should be made aware of the hospital policy on use two-way radios for all locations in which they will be working. Ensure that any outside broadcast vehicles equipped with radio-talkback and microwave link transmitters are parked as far away as practicable from patient treatment areas or wards.

(*Extracted from Medical Devices Agency Safety Notice SN 2001 (06) downloaded from www.medical-devices.gov.uk on January 2nd 2003. The full notice gives information on the technical basis for these warnings.*)

**252) Ninety reports of medical device malfunctions due to security equipment 1998-2001**

The Food and Drug Administration (FDA) received over 90 problem reports of medical device malfunctions related to EMI from magnetic field emitting security devices since 1998. The malfunctions were judged serious enough by the reporters (clinical users of these devices) to potentially cause patient injuries. Examples of malfunctions with implanted devices ranged from disturbances in the cardiac sensing operation of pacemakers, unintended firing of implanted cardiac defibrillators (ICDs), changes in drug delivery rates of infusion pumps, and over-stimulation of patients with neurostimulators resulting in severe pain or falls.

As a result, the FDA undertook a study of the EM fields emitted from the security screening systems to determine the nature of the EM fields seen by electronic medical devices worn by, or implanted in, patients passing near these screening systems. Measurements of the magnetic field emissions from security devices reveal that some security screening devices can emit fields at strengths that exceed the test level specified in some medical device standards. The FDA took action to alert users and manufacturers of active medical devices and security screening devices of the potential for interactions.

(*Taken from: "*Comparison of Magnetic Fields Emitted from Security Screening Devices with Magnetic Field Immunity Standards*" by Jon P Casamento of the FDA's Centre for Devices and Radiological Health (CDRH), presented at the IEEE 2002 International EMC Symposium, Minneapolis, August 19-23, pages 937-940 in the Symposium Record.*)

(*Editor's note: the standards referred to in Jon's paper were CENELEC draft standards prEN 45502, Part 2-1 for cardiac pacemakers and Part 2-2 for implantable defibrillators. The 2002 version of EN 60601-1-2 (the EMC safety standard for medical devices) includes a magnetic field immunity test of 3A/m but only at 50Hz, whereas the security screening devices he tested could emit fields of up to 1000A/m at frequencies between 200Hz and 100kHz and 3A/m up to 10MHz.*)

**253) Medical diathermy as a source of electromagnetic interference**

Medical diathermy is used for physiotherapy, to heat tissues throughout their volume. 27MHz continuous 'short-wave' diathermy can use RF powers of up to 400W, but is becoming unfashionable. 27MHz pulsed short-wave diathermy is just coming into fashion and uses average RF powers of around 40W. 2.45GHz microwave diathermy is out of fashion, people being scared off by the idea of 'microwave cooking'. There is also a technique known as Interferential Therapy which operates at 4kHz.

Electrosurgery equipment typically uses 500kHz. ‘Cutting’ typically uses 1200V and 400W, ‘Point Coagulation’ typically uses 2000V and 150W, ‘Spray Coagulation’ uses 380V and 80W, and ‘Blend’ uses 1800V and 300W (*the high frequency prevents the patient from receiving a fatal shock - Editor*).

There are significant levels of emissions from the diathermy and electrosurgery leads, and most theatre equipment is now designed to avoid interference from this source. ‘Bipolar’ diathermy technology reduces the interference caused; and most modern equipment uses sinusoids, which reduces the potential of harmonic emissions to cause interference problems.

A traction machine in a physiotherapy department has been seen to malfunction when a 27MHz diathermy system was switched on in the next room. The long leads associated with pacemakers make good antennas and can download large currents at 27MHz directly into the heart, damaging it. External pacemakers used during surgical operations have much longer leads than implanted pacemakers, and are a nightmare. Diathermy has also caused certain defibrillators to charge up and some pulse oximeters to give wrong readings.

*(Taken from: “*Surveying a hospital for electromagnetic interference*” by Lindsay Grant, Consultant Clinical Engineer, Royal United Hospital, Bath, U.K., IPEM conference “*Practical Methods for Mitigation of EMI and EMF Hazards within Hospitals*”, York, 28th January 2003. IPEM is the Institute of Physics and Engineering in Medicine, at: http://www.ipem.org.uk. Diathermy and electrosurgery are well-known by surgeons as causes of interference problems. For more examples see Banana Skins 83, 247, 248, 251, 257, 258 and 261.)*

**254) Medical device interference from mobile phones**

Actual reports of serious problems are hard to come by. However, in-house tests at the University of York, and field-test studies such as that commissioned by the Medical Devices Agency have shown that many types of hospital equipment are susceptible to RF radiation, although generally only at distances of less than 2m. Victims of EMI from mobile transmitters typically include diagnostic equipment such as ECGs, EEGs, pulse oximeters and other physiological monitoring equipment; plus therapeutic equipment such as infusion pumps, ventilators and defibrillators. Physiological monitoring has a bandwidth of around 100Hz and is very sensitive – so very susceptible. For example the sensitivity of an ECG is 1mV and of an EEG is 100µV, whereas ‘Evoked potential’ monitors can be sensitive to as low as 1µV.

The type of modulation employed by the mobile transmitter can be significant. For example, an external pacemaker we tested withstood a GSM modulated signal at 30V/m field strength, but TETRA modulation caused interference at 3V/m. GSM modulates its signal at 217Hz, whereas TETRA uses 17Hz which has a greater probability of lying within the pass-band of medical equipment.

We found that a distance of 1.2 metres was required for the medical equipment we tested to be safe. For comparison: Rice and Smith (Canada) found that 10 out of 14 devices failed with a 0.6W mobile phone at distances of under 500mm; Irnich and Tobisch (Germany) tested 224 devices and recommended a safe distance of at least 1 metre; The U.K.’s Medical Devices Agency tested 178 devices and found that 4% exhibited effects with mobile transmitters at 1 metre, although only 0.1% of them had serious effects at that distance (Bulletin BD 9702).

*(Taken from “*Mobile communication systems and medical equipment*”, by M P Robinson, I D Flintoff and A C Marvin, York Electromagnetics, University of York, IPEM conference “*Practical Methods for Mitigation of EMI and EMF Hazards within Hospitals*”, York, 28th January 2003. IPEM is the Institute of Physics and Engineering in Medicine, at: http://www.ipem.org.uk.)*

*(Also see: M P Robinson, I D Flintoft and A C Marvin, ‘*Interference to medical equipment from mobile phones*’, J. Med. Eng. Technol. vol. 21, p. 141, 1997. M L Rice and J M Smith, ‘*Study of electromagnetic interference between portable cellular phones and medical equipment*’, Proc. Canadian Med. Biol. Eng. Conf. p330, 1993. Steve Smye, ‘*Assessing the risk to medical equipment of interference from mobile phones*’, EMC York ‘98 Conf. Proc., July 1998, “*Electromagnetic compatibility of medical devices with mobile communications*”, Bulletin MDA DB 9702 March 1997 from the U.K. Medical Devices Agency, http://www.medical-*

*devices.gov.uk, "*Safety Notice SN 2001 (06)*", the U.K. Medical Devices Agency, www.medical-devices.gov.uk.)*

**255) MRI scanners as a source of electromagnetic problems**

Magnetic Resonance Imaging (MRI) uses very powerful static magnetic fields, up to 3 Tesla in the U.K., but systems with up to 8 Tesla are available and there is a trend towards using more powerful fields. This magnetic field can accelerate ferromagnetic objects with serious consequences. A patient was struck by an oxygen bottle while being placed in the magnet bore. Parts of a fork lift truck weighing 800 pounds were accelerated by the magnet, striking a technician and resulting in serious injury. A pair of scissors was pulled out of a nurse's hand as she entered the magnet room, hit a patient, causing a head wound. Dislodgement of an iron filing in a patient's eye during an MRI exam resulted in vision loss in that eye.

Implantable medial devices such as stents, clips, prostheses, pacemakers and neuro-stimulators are all potential hazards in an MRI scan, and devices should be tested for MR compatibility. It is known that pacemakers can be very sensitive to static magnetic fields of the order of 1 milliTesla. Monitoring equipment such as ECG, heart-rate, blood pressure, blood oxygen monitors are also of concern. MRI scanners also use intense RF fields, with most U.K. systems operating at 42.6, 63.9 or 127.8MHz.

*(Taken from: "*Electromagnetic fields in the hospital environment*", by Jeff W. Hand, Director, Radiological Sciences Unit, Hammersmith Hospitals NHS Trust, London, IPEM conference "*Practical Methods for Mitigation of EMI and EMF Hazards within Hospitals*", York, 28th January 2003. IPEM is the Institute of Physics and Engineering in Medicine, at: http://www.ipem.org.uk.)*

**256) The hospital EM environment often exceeds IEC immunity standards for medical devices**

E-M fields in hospitals. Broadband RF field measurements in the hospital environment have found that E fields can be up to 30V/m. The strongest sources included electrosurgical units, hand-held radios and VDUs. Power frequency magnetic field measurements in the hospital environment have found H fields up to 5A/m.

The strongest sources included power lines and supplies, patient monitoring equipment, VDUs and electrosurgical units. 63% of all E-field measurements and 7% of all H-field measurements made in the hospital environment exceeded proposed IEC immunity requirements for medical devices.

*(Also taken from: "*Electromagnetic fields in the hospital environment*", by Jeff W. Hand, Director, Radiological Sciences Unit, Hammersmith Hospitals NHS Trust, London, IPEM conference "*Practical Methods for Mitigation of EMI and EMF Hazards within Hospitals*", York, 28th January 2003. IPEM is the Institute of Physics and Engineering in Medicine, at: http://www.ipem.org.uk.)*

**257) Immunity issues with pacemakers**

Pacemakers have always been designed with interference in mind. When they sense signals outside of the normal signal range of 10 to 300 beats per minute they go into an 'interference mode' and pace in a backup safety mode. This will keep the patient alive but will make them feel very unwell. All modern pacemakers have bi-directional radio telemetry systems that allow the cardiology technician to send instructions to the pacemaker. The digital coding is robust, but it is an obvious point of entry for interference signals.

In general mains signals do not cause problems with pacemakers. Surgical diathermy can be a problem. There have been some reports of pacemakers being damaged and some currents being conducted down the lead and causing myocardial tissue fibrosis, with consequent loss of pacing function, but these are extremely rare. Arc welding has long been known to be contraindicated for patients who have pacemakers. The problem is mainly with spot welding as the interference generated can appear at roughly cardiac frequencies. There have been isolated reported cases of ventricular standstill when a therapeutic ultrasound unit's lithtripter is synchronised to the P wave of the ECG. RF physiotherapy equipment using pulsed and CW at 27MHz can cause interference problems – care needs to be taken and an expert involved in any discussion about patient treatment.

GSM mobile phones can be a problem when held very close to the pacemaker site. This is due to the 2.2Hz bursts of 900MHz signal at switch on and switch off, and 8.3Hz bursts during the ring phase. Patients are told to use the phone with the ear opposite the pacemaker site and not to keep it in their breast pocket. Otherwise there are no problems. Transcutaneous nerve stimulators (TENS) *(such as are used in slimming and muscle toning devices – Editor)*, are common sources of interference. They can cause complete inhibition of pacing and potential death. Patients who require TENS above the waist should be individually evaluated by the pacemaker clinic and safe levels of operation established.

A number of recent reports have indicated that Electronic Article Surveillance (EAS) systems in shops can be a problem. These normally only occur when pacemaker patients linger close to the security gates. Under some extreme circumstances the field can be sufficient to cause the pacemaker to revert to its emergency reset conditions. This is not life-threatening but can make the patient feel very unwell.

External pacemakers are particularly prone to interference because they have a much longer lead and the system is not entirely screened within the body Such systems carry a high risk in the hospital environment and patients need to be kept well away from physiotherapy departments which have potentially life threatening sources of interference. Mobile phones and hospital radios can also cause problems that may initiate dangerous cardiac arrhythmias.

*(Taken from "*Electromagnetic interference and cardiac pacemakers*", by Lindsay Grant, Medical Physics Department, Royal United Hospital, Bath, IPEM conference "*Practical Methods for Mitigation of EMI and EMF Hazards within Hospitals*", York, 28th January 2003. IPEM is the Institute of Physics and Engineering in Medicine, at: http://www.ipem.org.uk.)*

**258) Most medical devices fail EMC tests at first attempt**

It is quite staggering to discover that over 90% of medical electrical devices that we have tested have failed to comply with the standards applied for on the first attempt.

*(Taken from: "*Why 90% of medical devices fail conformity assessment the first time around*", by Donald J. Sherratt,* Medical *Stream Director, Intertek Testing Services, IEEE 2002 International EMC Symposium, Minneapolis August 19-23 2002, Workshops and Tutorial Sessions. Note that his graphs show 97% failing EMC tests to IEC 60601-1-2:1993 – which is easier to meet than the current versions of the generics – and 90% failing safety standards.)*

**259) EMC efforts are needed to save lives with wireless informatics in hospitals**

Healthcare need wireless informatics to reduce the numbers of patients dying from medical errors (such as lack of patient medical records). The electromagnetic environment in a hospital is very low, if no portable radio-frequency sources are near by. *(But see Banana Skin No. 257 – Editor.)*

But the EMI patient-injury risk is hard to calculate because the immunity of medical devices is largely unknown. The potential for EMI malfunction is very high, but these don't necessarily injure patients. Even though the patient-injury risk is small, it needs minimisation. Soon, wireless usage in top hospitals will not be optional, it will be essential. EMC efforts are needed to make it happen.

*(Taken from "*Wireless Informatics in Healthcare: Making it work*" by Bernard Segal, McGill University, SMBD Jewish Hospital, Montreal, speaking in the "Current EMC issues in healthcare" workshop session of the IEEE 2002 International EMC Symposium, Minneapolis, August 19-23 2002.)*

**260) Under-reporting of medical EMI incidents considered likely**

In the USA, the Food and Drug Administration (FDA) collects reports of medical equipment failure. Jeffrey Silberberg of the FDA's Centre for Devices and Radiological Health (CDRH) states that between 1979 and 1993 there were over 100 reports attributed to EMI. These include interference to a wide range of devices, including ECG, ventilators, infusion pumps and apnoea monitors, from a variety of sources including electrosurgery, fluorescent lights and radio transmitters.

The EMI reports form only a small portion of the 95,000 incidents reported to the FDA each year, but Silberberg and others believe there is widespread under-reporting of EMI incidents.

*(Taken from "*EMC of Medical Equipment*", Dr Martin P Robinson, University of York, N. J. Wainwright York EMC Services Ltd., EMV'99 Dusseldorf, Germany. Also, see – "*Performance degradation of electronic medical devices due to electromagnetic interference*", Jeffrey L Silberberg, Compliance Engineering vol. 10 p. 25 1993. An updated version was published in Compliance Engineering's European Edition's 1995 Annual Reference Guide as: "Electronic medical devices and EMI", pages F-10 - F-15, www.ce-mag.com.)*

*Editor's note: Other useful sources of information on medical EMC issues include the IPEM seminar mentioned in Banana Skin numbers 254-258, plus: "*Electromagnetic compatibility for medical devices: Issues and solutions*", FDA/AAMI Conference 1995, conference report edited by Stephen Sykes of the U.S. Food and Drug Administration, 1996, ISBN 1-57020-054-8; "*Electromagnetic compatibility / electromagnetic interference: Solutions for medical devices*", FDA/AAMI Conference 1997; "*Technical Information Report TIR-18 – 1997: Guidance on electromagnetic compatibility of medical devices for clinical/biomedical engineers – Part 1: Radiated radio-frequency electromagnetic energy*" – all published by the Association for the Advancement of Medical Instrumentation, http://www.aami.org.*

*For FDA's Centre for Devices and Radiological Health (CDRH) "Safety Alerts", public health Advisories and Notices, go to: www.fda.gov/cdrh/safety.html. For the FDA's "Med Watch" safety information and adverse event reporting program, go to: www.fda.gov/medwatch.*

**261) Tilting train interference problems**

The high-speed tilting train project on the West Coast Main Line has been hit by more problems after tests revealed it can interfere with signals. The hitch was discovered during a non-passenger run of the Virgin Trains Pendolino train between Crewe and Liverpool. It was discovered that electromagnetic interference from the controls driving the motors on the trains can change the lights on the signals.

The roll-out of the service, which is planned to run between London and Scotland, has already been subject to delays. Network Rail – the company that has taken over from the Railtrack – said it was now discussing the problem with Virgin, the Strategic Rail Authority and the Alstom company, which is building the Pendolinos. There is speculation that train's traction motors might have to be redesigned and that special filters will need to be fitted to the signals.

But a Virgin spokesman insisted on Friday that the company did not anticipate having to put back the autumn 2004 date for the Pendolinos to switch from 110mph to a full tilting mode of 125mph.

The trains were due to be introduced in full 125mph tilt mode on the West Coast line in May 2002. But a series of delays have seen the cost of the West Coast upgrade reach £9.8bn and have meant the Pendolino project timetable has slipped. Virgin has so far received 15 of its 53 Pendolinos.

But they are only running at 110mph in non-tilt mode and only on Tuesdays between London and Wolverhampton and on Wednesdays and Thursdays between London and Manchester. Virgin hopes to run Pendolinos on five days a week by the end of the summer and, by 2006, reduce journey times between London and Scotland by about an hour to four hours 33 minutes.

*(BBC News World Edition, Friday 2 May 2003, http://news.bbc.co.uk/2/hi/uk_news/england/2995355.stm. A similar item appears on Erik's Rail News for May 2003, at http://www.eriksrailnews.com/archive/may03.php, and we understand that another report on this interference problem appeared in the Daily Mail around the same time.)*

*A rail industry insider, who wishes to remain anonymous, brought the above news item to our attention – and adds the following comments…*

The fact that interference is taking place at a number of different sites raises the issue of general safety procedures associated with the installation of new equipment within the railway.

It is likely that the interference is probably due to the introduction of new rolling stock using motor drive systems based upon fast switching power converters (refer to Tim Williams' article "EMC Threat to Broadcast Bands", Approval, Nov/Dec 2001, pages 26-30).

As well as the threat to radiocommunications at 150kHz and above, interference is produced by these switching converters in the frequency range 10kHz to 150kHz. Unfortunately, this is outside the range covered by the present family of railway EMC standards, EN 50121-1 to -5.

However EN 50121 (and the Protection Requirements of the EMC Directive) <u>does</u> require that <u>all</u> EMC phenomena be addressed in the EMC control process, i.e. all interference sources and levels are to be identified and only equipment with sufficient immunity to them should be installed.

In new railway projects this process works well with equipment being designed installed and tested to the requirements of meeting the emission and immunity requirements of the EN 50121 family of standards.

The problem is that much of the equipment installed in the UK railway is based upon so called 'grandfather rights', meaning that equipment that has been in use within the railway for many years with no EMC problems being reported, *can be used in new projects without having to meet EN 50121*.

Clearly, if the electromagnetic environment of the railway network remains the same, the use of 'grandfather rights' is justifiable. But if the EM environment is significantly changed by the introduction of a new major source of interference (such as the Pendolino? or the Eurostar – see Banana Skin No. 41) the use of the 'grandfather rights' approach must be questionable in any part of the railway where the new interference source is to be employed.

**262) Railtrack did not know the electromagnetic susceptibility of much of its rail network**

The following excerpts are taken from a hearing into complaints from rolling stock suppliers Adtranz and Alstom against the infrastructure operator (Railtrack) – regarding the inability of Railtrack to provide technical data (including EMC data) for acceptance of new rolling stock onto the UK rail network.

<u>Adtranz/Alstom:</u> Railtrack still does not know where its infrastructure is or how it performs. Nor does Railtrack know where its own infrastructure is non compliant with its own norms. The result has been that Railway Group Standards fail to define in key respects, mainly electromagnetic interference and gauging, the actual requirements that Railtrack will demand compliance to when trains are presented for approval.

Railtrack's fundamental failure to know where its infrastructure is, how it performs and the condition that it is in, continues to produce extraordinary turbulence in the requirements for safety acceptance.

We have £500 million vehicles parked in the sidings. All those vehicles are built within existing gauges. They are built with lower interference levels than any of the vehicles in service and we are trying to get those vehicles approved against criteria which are spiralling towards the impossible and left to individuals and subjective appraisal.

<u>Railtrack:</u> Railtrack's inherited infrastructure is 57,000 track circuits of a variety of different types. Many of them have been introduced over a number of years, tens of years, thirty years

plus. Many of those track circuits were never designed for the concept of modern traction packages that we currently have being used today.

Most of them were originally designed for something like very statically controlled EMUs etc. A lot of those track circuits are susceptible to certain generated interferences that will come off these new trains. It is an inherent factor of the new train design. The track circuits which were installed and in many cases installed by BR do not necessarily meet today's standards.

Certainly the manufacturing requirement from Westinghouse or Alstom or previous companies that designed these track circuits would have designed it for work at a certain length. For reasons of fitting it to the infrastructure, the infrastructure will sometimes be of varying lengths, sometimes they are much longer in length because clearly if you could just increase it by 50% you can reduce the number of track circuits being fitted to the railway, has a nasty effect of making it far more susceptible to the EMC.

At the time the BR engineers did that, there was perfectly reasonable reason for doing it. They could make the track circuits work, they could make them reliable to operate the railway in a safe manner to detect trains. Unfortunately that same design criteria has made them more susceptible to the design of traction packages today.

Chairman: Sitting where we are if 15 years ago the British Railways Board had mandated that track circuit design ought to be a fairly limited range of track circuits that appeared to be roughly right in terms of emerging traction packages for the next ten years then we might not be sitting here now talking about electro-magnetic interference.

*(Taken from "*Hearing RE Adtranz/Alstom complaint about vehicle and route acceptance*", held on Tuesday 9th May 2000 at the Office of the Rail Regulator, London. Document reference 14419 Version 2 - Final. From: http://www.rail-reg.gov.uk/filestore/docs/adtranz-alstom.pdf or else go to the Rail Regulator's home page at http://www.rail-reg.gov.uk and enter 14419 into the search window.*

*Note that the Eurostar trains are still not permitted to travel north of London because they can interfere with track circuits. This problem became public in 1996 – see Banana Skin No. 41 at http://www.compliance-club.com/archive1/Bananaskins.htm – but seven years later the problem still has not been fixed.*

*Other examples of railway interference problems can be found in the "Banana Skins compendium" via a link from www.compliance-club.com or at: http://www.compliance-club.com/archive1/Bananaskins.htm, especially (at the time of writing) numbers: 12, 42, 94 and 115.)*

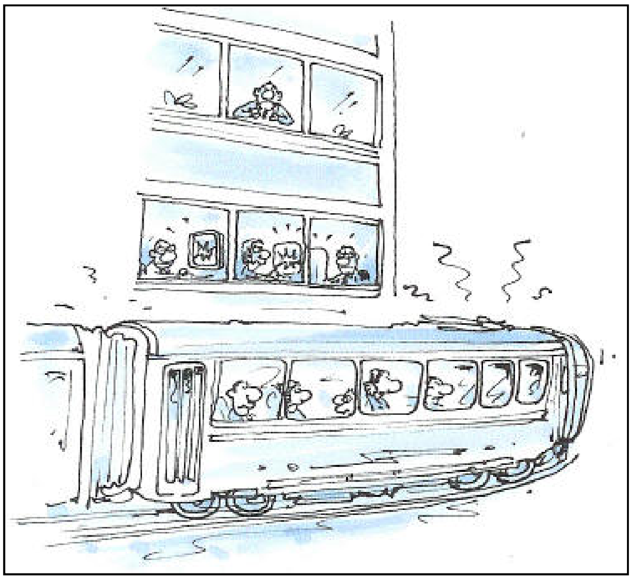
**263) Potential for interference from railways**

A report from York EMC Services for the Radiocommunications Agency has looked at the potential for interference from the various parts of the railway system. The following quotes summarise their conclusions:

"It is well known that the railway electromagnetic environment is much more severe than that found in most commercial and domestic premises. However, in many instances the railway runs very close to such premises. In fact, in the example of an inner city light rail scheme the railway effectively runs along public roads, which brings it into close proximity to non-railway premises and potential victim systems.

There are concerns about radio frequency emissions from railways and their potential to interfere with the operation of commercial radio services and other equipment, such as information technology equipment.

There is concern amongst CISPR and the radio community that the emission levels and measurement techniques set out in EN 50121 [the railways emissions standard] do not provide adequate protection to radio services. Some evidence has been found showing that such emissions are capable of interfering with electrical or electronic equipment and radio services operating adjacent to the railway lines. The findings of this study have implications for planned or existing buildings in which IT equipment will be used, where the buildings are situated very close (i.e. less than 10m) to electrified railway lines. There is a significant probability that the passing trains will interfere with PC monitors that are only a few metres away from the lines."



*(Taken from the Radiocommunication Agency's very helpful "*EMC Awareness*" website. When the RA was absorbed into OFCOM, this site was included in the 'Archives' section of their website, at: http://www.ofcom.org.uk/static/archive/ra/topics/research/RAwebPages/Radiocomms/index.htm.*

*OFCOM have also made a link from their 'active' site to the EMC Awareness site as follows: On their homepage http://www.ofcom.org.uk, click on 'Legacy Regulator Archives'. Then click on 'Technology Research'. Then click on 'RA' (Radiocommunications Agency), which takes you to what was the RA's home page. Find the "EMC Awareness" box and click on it. The website is also hosted at: http://www.emcuk.co.uk/awareness.)*

**264) Radar detectors interfere with SKY TV**

Radar detectors that warn drivers they are approaching a police speed trap can emit signals that cause interference to SKY digital television (and numerous other microwave communications systems).

Although it is suspected that this type of interference is widespread, only a small number of cases have been reported. This is because most people would attribute the freezing or break-up of their digital TV picture to a glitch in their equipment, or SKY's transmission, rather than interference. Relatively few people notice if this type of interference always occurs when a particular vehicle (fitted with a radar detector) passes their property.

The European Commission's Directorate on General Enterprise have been made aware that equipment approved to their Automotive EMC Directive 95/54/EC has been found to interfere with radio systems operating in the 10-20GHz frequency range. It used to be considered that products that came under the 95/54/EC and were 'e' marked were excluded from being covered by the EMC Directive 89/336/EEC and so did not require CE marking.

However, it is now the Directorate's opinion that 89/336/EEC applies to all of the EMC aspects that are not covered by 95/54/EC. Since 95/54/EC only covers emissions up to 1GHz, 89/336/EEC covers emissions from automotive equipment from 1GHz to 400GHz. Sadly, most of the applicable test standards under 89/336/EEC only test emissions to 1GHz, but at least the Protection Requirements of 89/336/EEC require that no interference is caused regardless of the frequency.

In the USA, where satellite TV is not very common, significant interference has occurred to satellite terminals used to link retail establishments with remote computers for verifying credit card transactions. Accordingly, the Federal Communications Commission (FCC) has announced that from August 2002 all radar detectors manufactured or imported in the USA must meet the Part 15 emissions limits in the 11.7-12.2GHz band.

*("*Proposed changes in the Guidance to the Automotive EMC Directive 95/54/EC and the EMC Directive 89/336/EEC to jointly impose both "e Marking" and "CE Marking" on vehicles and vehicle equipment*", ERA Technology Ltd, Safety and EMC Newsletter, Number 68, April 2003, page 7. Also see: "*FCC stiffens rules for radar detectors*", Conformity, September 2002, page 8. http://www.conformity.com. And: "*All radar detectors marketed must be FCC approved effective October 27, 2002*", DA 02-2852 October 28 2002, http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-02-2852A1.pdf?date=021028.)*

When comparing the phenomena regulated by both Directives it becomes apparent that harmonised standards under 89/336/EEC cover a wider range of phenomena than regulated by 95/54/EEC. The latter Directive limits itself to regulating radiated emissions below 1 GHz and for safety critical components regulates higher levels of immunity. This thus implies that it doesn't harmonise all the protection requirements specified in Directive 89/336/EEC, reason for which it is incorrect to argue that Directive 89/336/EEC doesn't apply to such products at all. A logical line of thought is that it only ceases to apply for the phenomena, which are regulated by the automotive EMC Directive and thus continues to apply for all other phenomena.

*(Taken from: "*Guidance in the EMC guide on the relation of the EMC and Automotive EMC Directive*" Brussels, 15 January, 2003, Ref: 07-28 EMC-AUTOMOTIVE, DG ENTR/G/3. Does this mean that motor cars should be CE marked, and have a Declaration of Conformity to the EMC Directive, after all?)*

**265) Examples of interference with satellites**

The wake shield experiment was launched in February 1994, but the small satellite used could not be deployed due to EMI with its attitude control system. This was caused by inductive coupling (crosstalk) between the unshielded attitude control sensor cable and the power bus of the spacecraft. This was an unpleasant lesson learned at the cost of a failed experiment.

The Gamma Ray Observatory satellite experiment launched in 1991 experienced a transponder lockup that prevented the spacecraft from receiving control commands. EMI from a ground source (plus design problems) was the cause.

The NOAA-11 weather satellite was launched in 1988. In September 1991 a series of phantom commands were observed and determined to be caused by EMI due to a noisy VHF (Very High Frequency) environment.

The NOAA-12 weather satellite was launched in 1991. In September 1991 it experienced phantom commands when it flew over Europe, due to the heavy commercial VHF environment over Europe.

*(The above incidents are items 2.2.2, 2.2.4, 2.2.5, and 2.2.6 in NASA Reference Publication 1374: "*Electronic systems failures and anomalies attributed to electromagnetic interference*" published in July 1995.*

*Download it from: http://trs.nis.nasa.gov/archive/00000296/01/rp1374.pdf.)*

**266) Saturn Launch Vehicle interference**

During on-pad checkout at the Kennedy Space Centre prior to one of the early development test flights of the Saturn launch vehicle, the range safety receivers detected an extraneous signal. Because these receivers processed commands for engine cut-off, arm and destruct, a thorough investigation was conducted.

The spurious signals were caused by the multitude of telemetry transmitters located on board to collect test data, however, none of these were operating near the range safety receiver frequency.

Further investigation determined that the various RF signals were ‘mixing’ and producing intermodulation products in a non-linear circuit created by metalwork that was not properly bonded, namely the hinged cable tray covers and chain handrails on the gantry.

*(The above incident is item 2.1.1 in NASA Reference Publication 1374: “*Electronic systems failures and anomalies attributed to electromagnetic interference*” published in July 1995. Download it from: http://trs.nis.nasa.gov/archive/00000296/01/rp1374.pdf.)*

**267) Safety-critical residual current detector (RCD) tripped by mobile phone**

The 'incident', which occurred at a site handling radioactive material in 1996(?) was as follows: It was noticed that use of a mobile phone within approx. 1.5m of a portable RCD caused the RCD to trip. The RCD was connected in the supply to a monitor for 'in air' alpha particles. The concern was that such monitors connected via RCDs could be inadvertently tripped without being noticed. This could result in a failure to detect hazardous radiation levels.

Although, as far as I am aware, there was no such failure in this case. Portable radios caused the same effect up to 2.5m from the RCD. This illustrates a general principle that where electronic devices are employed for 'passive' monitoring to reduce risks to health or safety, steps should be taken to avoid such false tripping resulting from EMI, and regular tests carried out to verify the operation of the monitor. Hopefully, the immunity of RCD's has improved since the time of this incident, but the general principle remains.

*(From Simon Brown of the UK’s Health and Safety Executive, 19th June 2003.)*

**268) USS Forrestal disaster**

With the war in Southeast Asia providing experience for all phases of naval operations, several carriers which normally belong to the Atlantic Fleet were occasionally routed to WESTPAC duty, and thus it was that on June 6, 1967, Forrestal left Norfolk, Virginia, for what was to be her first combat deployment.

Carrying Air Wing 17, Forrestal was the first U.S. carrier to be built from the keel up with an angled deck. She carried East Coast squadrons, two F-4B squadrons squadrons; VFs 11 and 74; VAs 106 and 46, flying A-4Es; RVAH-11, with RA-5C Vigilantes, for which the big carrier had undergone major modification for the IOIC reconnaissance intelligence system; the KA-3Bs of VAH-10; and VAW-123, flying E-2As.

Forrestal arrived on Yankee Station on July 25 and immediately began combat operations, her aircraft flying 150 sorties during the next 4 days, without the loss of a single aircraft. At 10:52 A.M. on July 29, the second launch was being readied when a Zuni rocket accidentally fired from an F-4 Phantom parked on the starboard side of the flight deck aft of the island.

The missile streaked across the deck into a 400 gallon belly fuel tank on a parked A-4D Skyhawk. The ruptured tank spew highly flammable JP-5 fuel onto the deck which ignited spreading flames over the flight deck under other fully loaded aircraft ready for launch. The ensuing fire caused ordinance to explode and other rockets to ignite.

Spread by the wind, the flames engulfed the aft end of the stricken ship turning the flight deck into a blazing inferno.. Berthing spaces immediately below the flight deck became death traps for fifty men, while other crewmen were blown overboard by the explosion.

Nearby ships hastened to the Forrestal's aid. The Oriskany, herself a victim of a tragic fire in October 1966, stood by to offer fire-fighting and medical aid to the larger carrier. Nearby escort vessels sprayed water on the burning Forrestal and within an hour the fire on the flight deck was under control. But secondary fires below deck took another 12 hours to contain. The damage and loss of life was catastrophic.

The four-and-a-half-acre flight deck was littered with pieces of aircraft, as men struggled to clear away bombs and ammunition, throwing the ordnance over the side. One young 130-pound lieutenant found the strength to heave a 250-pound bomb overboard.

The Zuni rocket that was accidentally fired from an F-4 Phantom and started the fire is believed to have been triggered by a combination of the powerful fields at deck level from the ship’s radar and an incorrectly fitted shielded cable connector.

(*From http://forrestal.org/fidfacts/page13.htm*)

**269) Government admits radio towers, units were too close**

Eastern Creek has emerged as a possible site for Sydney's five commercial AM radio transmitters as the NSW Government admitted yesterday it approved residential development too close to the Homebush Bay towers. The Opposition has said the 1998 decision to allow Payce Constructions to build a 1200-unit residential development within 200 metres of the tower used by 2SM and 2UE was "a first-class bungle". But the Minister for Planning, Andrew Refshauge, said his department had acted with the best evidence before it and that no one had raised the issue of electromagnetic radiation from the towers when the masterplan was advertised in 1998. "There was no information to suggest radio broadcasts would cause any problem despite the fact the proposal was advertised widely. There was no submission made that would suggest that there was any problem."

The Herald reported yesterday that the Australian Communications Authority had warned PlanningNSW 14 months ago that there were concerns about electromagnetic radiation from the tower, which could cause serious interference with electrical and electronic equipment. The authority also raised potential health risks associated with exposure to high-powered electromagnetic radiation. Waterside, being built in Bennelong Road, is so close to the tower used by 2UE and 2SM that it is within the "drop zone" - the area usually kept clear in case a tower falls. This occurred recently in Brisbane, when DMG's tower was sabotaged and toppled, putting the station off air for several days.

The Opposition spokesman on planning, Andrew Humpherson, yesterday accused the Government of trying to cover up the debacle which he said had exposed taxpayers to substantial costs and claims for compensation, not just from the radio stations, but also from the developer and people who had bought the units. "We need answers. Just what was the Government aware of in 1998?" Mr Humpherson said. Dr Refshauge's office said yesterday that there had been no submission from the broadcasters when the 1998 plan for residential development was exhibited. But the chief executive of Commercial Radio Australia, Joan Warner, said the industry had commented on the plan.

PlanningNSW, the Sydney Olympic Park Authority, broadcasters and the Australian Communications Authority are studying Eastern Creek as a relocation option.

*(By Anne Davies, Urban Affairs Editor, Sydney Morning Herald, February 18 2003, http://www.smh.com.au/articles/2003/02/16/1045330466812.html, sent in by Chris Zombolas of EMC Technologies Pty Ltd*., *www.emctech.com.au.*)

**270) New type of light bulb claimed to interfere with satellite communications**

A Maryland company will soon be manufacturing energy-saving light bulbs that almost never wear out. But a host of satellite radio broadcasters are crying interference.

According to a recent article in the Wall Street Journal, Fusion Lighting, Inc., of Rockville, MD, the manufacturer of the microwave powered bulbs, is drawing fire from Sirius Satellite Radio, Inc. and XM Satellite Radio Holdings, Inc. because the bulbs emit radio waves that directly interfere with satellite radio broadcasts. The year-long battle has seen the combatants engage in debate before the Federal Communications Commission (FCC), a private testing laboratory in Columbia, MD, and, in the near future, it appears, in courtrooms in Texas and Maryland.

Fusion began manufacturing specialty light bulbs in the 1970s, when its microwave powered ultraviolet bulbs were used in ink drying equipment in specialty industrial applications. The bulbs operated in frequency bands reserved for industrial, scientific and medical equipment.

When the company sold the ultraviolet business in 1994, Fusion's investors looked for broader applications for the light bulb technology, and hit on the idea of marketing the microwave bulb's energy efficiency and long life for broader commercial applications. Fusion says that it's now about a year away from commercial sales of the bulbs for use in lighting applications as diverse as gas stations and airport runways.

Trouble is that the lights make real the prospect of highways being lit up at night by hundreds of microwave bulbs that could, claim some, silence the satellite broadcasts. Understandably, the satellite broadcasters aren't standing for it, each having paid the government more than $80 million dollars for the right to broadcast on the contested frequencies.

Last year, the FCC attempted to broker a compromise between the parties, with Fusion eventually agreeing to reduce emissions from its bulbs by 95% by putting a metal casing around the microwave generator, using a metal reflector and coating the glass over the light. Not good enough, said the satellite broadcasters, who insisted on an emissions reduction of 99.9%. The FCC says that it's still months away from reaching a decision on the matter.

Meanwhile, Sirius has brought suit against Fusion, charging that Fusion executives "charged Sirius with securities fraud and dishonesty" in that company's efforts to raise additional capital. In its prospectus, Sirius mentions that "new devices may interfere with our service," but makes no mention of light bulbs. The CEO of Fusion reportedly raised the issue of Sirius' limited disclosure with a friend at Lehman Brothers Holdings, which was offering the Sirius shares, and the concern was eventually escalated to the underwriters handling the offering. Fusion has filed a countersuit against Sirius alleging defamation. (*From "*Bulb Manufacturer Lights Up Spectrum Wars", *News Breaks. Conformity, Vol. 6 No. 10, October 2001, www.conformity.com.*)

**271) Power Line Communication can interfere with radio astronomy**

Power line communication (PLC) system which extends the available frequency bandwidth up to 30 MHz has been proposed in Japan. The electromagnetic interference problems on PLC had been investigated by the PLC study group organized by the Ministry of Public Management Home Affairs, Post and Telecommunications (MPHPT). The study group held collaborated field experiments of the PLC facility and we measured interferences caused by the PLC facility in the HF and UHF bands in order to evaluate the influences of the expansion of PLC bandwidth on radio astronomical observations.

In the field experiment, two sets of PLC modems (SS and OFDM) were tested as an access system. During the PLC modems were on, the HF spectra observed showed strong increase of the noise-floor level, and it was found that the PLC noise exceeded the level of galactic noise by more than 30 dB. In UHF band, spurious emission around 327 MHz was identified. In both HF and UHF band, the interferences exceeded the limit of harmful interference level for radio astronomical observation which is given in Recommendation ITU-R TA769-1. Safety distances where the Recommendation was satisfied are estimated to be 219 km and 12 km at 9.2 MHz and 327 MHz, respectively. PLC seems to be a harmful interference source for the radio astronomical observation in both HF and UHF bands.

(*From: "*Interference measurements in HF and UHF bands caused by extension of power line communication bandwidth for astronomical purpose*", http://www.qsl.net/jh5esm/PLC/isplc2003/isplc2003a7-1.pdf. This item was found at: http://www.arrl.org/tis/info/HTML/plc, which has 24 pages of information and links on PLC/PLT.)*

**272) Interference with early ABS and Airbag systems**

Early ABS systems on both aircraft and automobiles were susceptible to EMI. Accidents occurred when the brakes functioned improperly because EMI disrupted the ABS control system. For aircraft, the initial solution was to provide a manual switch to lock out the ABS function when it was inoperable due to EMI and to use the normal braking system. Later, the solution was to qualify the ABS system prior to flight, based in the expected electromagnetic environment they would be exposed to.

For automobile systems, the solution was to ensure, if EMI occurs, that the ABS system degrade gracefully to normal braking – essentially an automatic version of the aircraft manual switch. Eventually, automobile ABS was qualified by EMI testing before procurement.


During the early years of ABS, a particular make of automobile equipped with ABS had severe braking problems along a certain stretch of the German Autobahn. The brakes were affected by a nearby radio transmitter as drivers applied them on a curved section of highway. The near-term solution was to erect a mesh screen along the highway to attenuate the EMI.

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

*(The above examples include items 2.3.1.16 and 2.3.1.17 from NASA Reference Publication 1374 (RP-1374), "*Electronic Systems Failures and Anomalies Attributed to Electromagnetic Interference*", which can*

*be downloaded from: http://trs.nis.nasa.gov/archive/00000296/01/rp1374.pdf. They also include examples taken from "*Study to predict the electromagnetic interference for a typical house in 2010*" by Anita Woogara, Bristol University, & Smith Group, 17 September 1999 – this and many other interesting documents may be found by hunting around the (legacy) Radiocommunication Agency's website hosted on Ofcom's site at: http://www.ofcom.org.uk/static/archive/ra/rahome.htm"*

**273) RSGB advice on identifying and locating sources of interference**

The RSGB EMC Committee receives many enquiries from members about interference to reception of amateur radio signals. Accordingly, the RSGB (Radio Society of Great Britain) has produced a leaflet that gives advice about identifying and locating sources of Radio Frequency Interference (RFI, also called electromagnetic interference or EMI). Issues covered include…

- TVs, set-top boxes, Cable TV
- Switch-mode power supplies (e.g. 'lump in a cord' or 'plug-top' devices)
- Lighting
- Electric motors
- Thermostats
- Computers
- Intruder alarm systems
- Telephones and fax machines

(*Taken from the Radiocommunication Agency's useful "EMC Awareness" site at www.ofcom.org.uk/static/archive/ra/topics/research/RAwebPages/Radiocomms/index.htm, from its "Interference" section on: "Household Appliances and Electronic Equipment".*

*(Note that since the RA was subsumed into OFCOM, www.ofcom.org.uk, in December 2003, all the old RA webpages are now running in the 'legacy' section OFCOM's website. The RA's site, of course, contains a great deal of valuable research that they had done into EMC, and this is also on OFCOM's legacy site as part of the original RA website. How long this valuable resource will be maintained by OFCOM is unknown. It is also not known if OFCOM are going to continue the RA's valuable research on EMC – more important, in these days of increasing spectrum use and more novel sources of interference, than ever before. If any OFCOM representatives would like to comment on these issues, we will be pleased to print their letters.*)

**274) Spacecraft engine disabled by voltage spikes**

Europe's Smart-1 spacecraft, which is en route to the moon, has an engine problem that could leave the vehicle stranded in space. Engineers at the European Space Agency are hard at work on software they hope will rescue the probe, and plan to transmit it to the spacecraft next week. Smart-1 is powered by an ion thruster, which produces thrust in one direction by accelerating xenon ions in an electric field in the other direction. Although this creates only about the same thrust as the weight of a postcard, the engine works continuously, gradually increasing the size of the spacecraft's elliptical orbit until it is captured by the moon's gravitational field, a process that takes 15 months.

Soon after the spacecraft was launched, the engine started switching off repeatedly. The spacecraft's circuitry is sensitive to high-energy protons from the sun, which generate rogue voltage spikes. Engineers routinely build capacitors into circuits to mop up any voltage induced in this way. But after launch, the team found to its dismay that the mopping up feature had been omitted from some key circuits. Each time a high-energy proton hits a particular optical sensor, it generates a spike that causes the on-board computer to switch off the engine, called a "flameout".

*(Taken from the "This Week" section, New Scientist, 31 January 2004, page 14, www.newscientist.com.)*

**275) 25,000 complaints of telephone interference in 1994**

In 1994 the Federal Communications Commission (FCC) in the U.S.A. was receiving about 25,000 complaints per year from people unable to use their telephones because of interference from nearby radio stations. It is believed that this number represents only a tiny fraction of the actual instances of this type of interference.

The FCC's Field Operations Bureau (FOB) conducted a study, which found that although most residential telephones are susceptible to receiving interference, manufacturers can design telephones to be interference-free.

The transmitting stations most likely to be involved in interference complaints are citizens band (CB), broadcast, and amateurs. Transmitted power was not a significant factor: one-third of the transmitters used under ten watts. The study also found that filters cannot be relied upon to eliminate telephone interference. In two out of three cases in which they were tried during the study, they did not work.

*(Taken from: "*Interference Free Telephones*", FCC (Federal Communications Commission, Washington D.C., U.S.A., News media information 202/632-5050, May 4, 1994, indexed at: http://www.fcc.gov/Bureaus/Common_Carrier/News_Releases/1994/index3.html, download from: http://www.fcc.gov/Bureaus/Common_Carrier/News_Releases/1994/nrcc4019.txt)*

**276) CAA tests reinforce the decision to restrict use of cellphones in aircraft**

In October 2002, a set of avionic equipment was tested under controlled conditions in a test chamber for susceptibility to cellphone interference. General aviation avionic equipment, representative of earlier analogue and digital technologies, was used. The equipment, comprising a VHF communication transceiver, a VOR/ILS navigation receiver and associated indicators, together with a gyro-stabilised remote reading compass system, was assembled to create an integrated system.

The tests covered the cellphone transmission frequencies of 412MHz (TETRA), 940MHz (GSM900) and 1719MHz (GSM1800), including simultaneous exposure to 940 and 1719MHz. The applied interference field strengths were up to 50 volts/metre for a single frequency, and 35 volts/metre for dual frequencies.

The following anomalies were seen at interference levels above 30 volts/metre, a level that can be produced by a cellphone operating at maximum power and located 30cms from the victim equipment or its wiring harness.

- Compass froze or overshot actual magnetic bearing.
- Instability of indicators.
- Digital VOR navigation bearing display errors up to 5 degrees.
- VOR navigation To/From indicator reversal.
- VOR and ILS course deviation indicator errors with and without a failure flag.
- Reduced sensitivity of the ILS Localiser receiver.
- Background noise on audio outputs.

Most anomalies were observed at 1719MHz.

The results of the tests endorse current policy that restricts the use of cellphones in aircraft.

The CAA will remind operators about the specific risk from cellphone usage on the flight deck, and recommend that confirmation be obtained from passengers at check-in that cellphones in their luggage have been switched off

*(Taken from the Radiocommunication Agency's "*EMC Awareness*" website, now at: http://www.ofcom.org.uk/static/archive/ra/topics/research/RAwebPages/Radiocomms/index.htm. The website is also hosted at: http://www.emcuk.co.uk/awareness.)*

**277) Interference issues on a research and recovery vessel**

The experiences of the crew of the research vessel (R/V) Deep Scan, a privately owned research and recovery ship, offer some insight into the complexities of integrating commercial off-the-shelf (COTS) computing equipment into a shipboard electromagnetic environment.

R/V Deep Scan is constructed as a commercial vessel with many of the electrical characteristics of military mine-clearing ships. Its hull and deck structures are constructed from wood, closed cell foam and fibreglass, and it shares EMI/EMC problems common to non-metallic ships.

Computing equipment on board is said to be compliant with FCC Part 15 for radiated emissions. A commercial workstation processes sonar and navigation track data from multiple transducers. A 386 PC processes both electromagnetic survey data from multiple detection transducers and data for navigation. Navigation data is provided by COTS GPS (Global Positioning System) and LORAN-C receiver systems. Depth information is provided by COTS depth sounding equipment. Heading data is provided by a COTS fluxgate compass.

Operating the marine VHF transmitter at more than 1W begins to corrupt collected data, and any use of HF SSB transmission causes the COTS computing equipment used for magnetic data collection and navigation to enter states that challenge rational explanation.

FCC rules limit the levels of unintentional electromagnetic radiation, but the close proximity of COTS computing equipment (the vessel is under 60 feet long) to the antennas used for data collection and communications is largely responsible for disruption of operations due to the EMI the COTS equipment generates.

EMI generated by the switching power supplies in the COTS equipment slightly degrades the LORAN-C signal-to-noise ratio through radiated coupling. COTS computing equipment generates sufficient radiated interference on the HF bands to render HF communications impractical. Broadband interference and harmonics from COTS computing equipment interfere with communications reception on selected VHF channels, in some cases enough to prevent useful communications.

Daily operations on board R/V Deep Scan are influenced by the EMI and susceptibility problems associated with the use of COTS computing equipment. Responding to a call on the VHF radio presently requires the crew to wait for a logical break in survey operations, or requires termination of survey operations. During survey operations, monitoring some VHF channels is not possible, HF transmission is impossible and HF reception is seriously degraded.

*(Taken from the Radiocommunication Agency's "*EMC Awareness*" website, now at: http://www.ofcom.org.uk/static/archive/ra/topics/research/RAwebPages/Radiocomms/index.htm. The website is also hosted at: http://www.emcuk.co.uk/awareness.)*

**278) Inverter drive interferes with ultrasonic level sensor at water treatment plant**

Problems associated with electrical noise have been solved at Northumbrian Water Broken Scar water treatment works in Darlington, County Durham. Such problems are an inevitable element of major pump installations, especially where large inverter drives are involved. This is sometimes a major problem for instrumentation, which generally involves cables carrying a smaller signal between a sensor and a control and analysis unit.

At Broken Scar, a large inverter drive meant that there was very high electrical noise. The ultrasonic level measurement unit that was originally installed, which used a coaxial cable to carry a signal, was swamped and unable provide a reliable measurement. The solution was a

Pulsar ultrasonic level measurement system …. performing an initial (digital) conversion on the signal at the transducer head, communicating digital information to the signal analysis. Despite the noise still being present, the system can discriminate between noise and the "true" signal to give a reliable measurement.

*(Adapted from an advertisement for Pulsar Process Measurement Ltd, in Plant and Control Engineering Magazine, Oct/Nov 2003, page 11.)*

**279) Mains supply dips getting worse**

We have seen an increase in AC mains supply dips from typically seven per year to eighteen, which is causing increased losses in production.

*(A comment by a representative from a major steel manufacturing company at the IEE's Wales South-East & Wales South-West Power Specialist section's "*Power Quality Seminar*", held at the University of Wales Swansea on Wednesday 12th November 2003.)*

**280) Increasing interference with Public Safety Communications in USA**

Signals from wireless communications transmitters are continuing to create significant interference issues for public safety officials, according to a recent report in the Washington Post. The interference problems reportedly stem from the close proximity of spectrum allocations for public safety communications and some older style wireless telecommunications technologies, which operate in the 800 Megahertz band. As we've previously reported (see Conformity, August 2002), more than 70 government agencies in 27 states have reported interference problems with wireless communications services used by public safety officials.

According to the *Post* article, communications problems most often arise when a public safety official (such as a police officer) is far from a transmitter that carries emergency radio signals but close to a transmitter for a wireless system carrier. In these cases, the signal from the wireless system overwhelms the weaker emergency signals, effectively blocking emergency communications.

The communications system operated by Nextel Communications appears to remain the principal source of most of the interference complaints. The Nextel network was originally cobbled together in the 1980s from underutilized portions of spectrum allocated for limited specialty uses. However, as the Nextel network has grown, its use of spectrum has begun to overlap with the frequencies used by public safety agencies.

State and municipal public safety authorities are responding in various ways to the continuing problem. Some jurisdictions are attempting to upgrade the communications infrastructure to provide stronger signals to radios operating on public safety bands. Still others are attempting to pass ordinances that require wireless carriers to certify that their signals do not interfere with public safety communications. Meanwhile, some police officers have reportedly found a simpler solution to interference with public safety communications bands, They carry their own cell phones!

*(From: "*Wireless Interference with Public Safety Communications Growing*", Conformity, November 2003, pages 8 and 10, http://www.conformity.com.)*

**281) Interference issues within UK railway networks**

Historically, EMC issues on railways have been dominated by the possibility of interference from high power electric traction supplies, particularly DC, affecting safety-critical low power train detection equipment. The introduction of switched traction controllers raised further concerns and early variable frequency chopper drives have caused incidents, leading to the adoption of fixed frequency choppers for DC traction drives. By the time traction inverter drives for AC traction became commercially attractive, due to the introduction of GTO thyristors and subsequently IGBTs, the potential risk was well understood and care has been taken to design traction drives to be compatible with train detection systems, either by design or high-integrity monitoring.

Now, probably the greatest threat to train detection is to older track circuits operating on the same frequency as the AC utility used to produce the DC traction supply and older trains without power electronic traction controllers. In a recent incident on the UK network, a failure on the rectifier of a DC traction supply was detected by a number of new power electronic trains being brought to a halt by their interference current monitoring units even though each train was perfectly healthy.

*(From: "*GM/RT8015 and Safety*" by Jeff Allen and David Bulgin of the Rail Safety and Standards Board, presented at the IEE Seminar "*EMC Assurance in a Railway Environment*", 9th September 2003, www.theiet.org.)*

**282) New Automotive EMC Directive includes transient immunity tests**

As part of the development of this directive (*Automotive EMC, 2004/104/EC – Editor*), it has become evident that many aftermarket devices can be found to be susceptible to the many switching events on a vehicle. This can be simply audio clicks or, worst case, result in hardware failure of the component resulting in damage to the vehicle itself.

For this reason, and following lobbying by the vehicle manufacturers, the committees responsible for the directive have included in this latest draft requirements for all ESAs *(electronic sub-assemblies – Editor)* to be immune from a series of transient events.

*(From: "*Transient Test Requirements for "e"-Marking – Necessity or Bureaucracy?*", by James Gordon-Colebrook and Alex Mackay of 3C Test Ltd, presented at the Automotive EMC 2003 Conference, 6th November 2003, http://www.AutoEMC.net.)*

**283) EMC Problems with Speed Detection Cameras cost Victoria Government AUS$30 Million**

The state government of Victoria, Australia, has commissioned a special investigation into the Fixed Digital Speed Detection Cameras. This follows from the report of the independent testing of the fixed digital speed detection cameras, commissioned by the Department of Justice after concerns were raised about erroneous readings and incorrect infringement notices. On-site testing, engineering investigations and EMC testing showed the occurrence of both 'over-readings' and 'under-readings'. The faulty readings were due to electromagnetic interference, poor installation and maintenance and degradation of the in-road sensors.

The faulty speed readings resulted in the issuing of fines and cancellation of driving licences, and this has called into question the reliability of electronic equipment used throughout the state's traffic control measures and for other law enforcement activities. Many motorists who have had their licences cancelled are threatening to sue the state for damages and consequential losses. The State government has allocated about AUS$30 million to reimburse the fines imposed on motorists and to compensate those with claims for losses resulting from licence suspension due to penalties from the flawed cameras. The government will also have to meet the cost of replacing or improving the 41 fixed cameras throughout the city's road grid.

*(From Chris Zombolas, EMC Technologies Pty Ltd., Melbourne, Australia, www.emctech.com.au. Also see the media release from the Premier of Victoria, Friday, 14 May 2004: "*Government acts on fixed speed cameras*"; http://www.justice.vic.gov.au/speedcameras; and Melbourne Age, 15 May 2004: "*$26 million Speed Payout*".)*

**284) TETRA interference with TV reception**

The new emergency services radio system, called Airwave, has been blamed for interfering with television reception, but where the problems occur the fault lies with the filters on domestic aerial amplifiers. Trade and Industry Minister Steven Timms, in a Parliamentary written answer, said: "OFCOM is aware of instances of interference to domestic installations from Airwave radio base stations. In all the instances so far investigated the consumer's own masthead aerial amplifier, used to boost weak signals, has had a pass-band wide enough to boost the television signal and, inadvertently, the unwanted radiocommunications signal *(from Airwave – Ed.)*."

Airwave is being rolled out across Great Britain for police and public safety communications, with completion due by 2005, when existing frequencies will be withdrawn. It is a digital system based on the ETSI-approved TETRA (Terrestrial Trunked Radio) standard.

Mr Timms went on: "Testing has shown that the TETRA transmitters were operating correctly and within their designated licence parameters. In most cases a suitable filter fitted between the masthead amplifier and the TV aerial will resolve the interference, and affected residents have been advised to have such filters fitted. As a goodwill gesture Airwave has arranged for filters to be fitted to the affected television installations in certain circumstances."

*("*Aerial amplifiers cause Tetra TV interference*" from the IEE's EMC Professional Network's "EMC Industry News 2004-01-15", 18th January 2004, www.theiet.org. TETRA has also caused significant problems for radio activated vehicle security systems, see Banana Skin No. 54. Other Banana Skins that mention TETRA are: 121, 122, 124, 252, 255 and 277.)*