Radiofrequency EMFs and Health Risks

This article is separated into 8 sections, each of which can be individually downloaded. It is a 'work in progress' incorporating new information whenever time permits.

Section 5
Driving hazards

Driving hazards

Car systems

Electronic dash panels produce high-frequency radiation, and more cars are being fitted with an in-built Bluetooth microwave communications system. This will talk to your mobile phone and any other Bluetooth-enabled electronic device. The effects on people are similar to other digital wireless LAN (local area network) systems. Radio-frequencies are also being used to sense the driver, electronic keytag in some cars, and other vehicle system functions.

Many upmarket, modern cars are being fitted with an in-built, continuously active, Bluetooth microwave communications system. This will talk to your mobile phone and RF CANBUS or any other Bluetooth-enabled electronic device. These expose the driver and front passenger to continually pulsing microwaves. We do not recommend the use of Bluetooth in cars and suggest you get these physically disconnected by your garage.

Japanese drivers have been using in-car Internet access since 1997. In December 2009 it was revealed that Ford, Mercedes, BMW, Chrysler, General Motors & Cadillac are all offering in-car connectivity. Autonet Mobile, the producers of the hardware, say the system is designed to support several devices at once. Apparently one-third of people surveyed by the Consumer Electronics Association want to check e-mail or have internet access in cars. Letting people log on will be a big selling point among people in their 20s, who were about 28% of the driving population in 2010. It also incorporates a docking station so you can move it from one car to the next.

The system installed by General Motors, called Chevrolet Wi-Fi will create a WiFi hot spot 300 feet in diameter around the vehicle.

US security researchers found that the computer systems used to control modern cars were easily subverted. They showed how to kill a car engine remotely, turn off the brakes so the car would not stop and make instruments give false readings. They concentrated on the electronic control units (ECUs) scattered throughout modern vehicles which oversee the workings of many car components. Individual control units typically oversee one subsystem but ECUs communicate so that many different systems can be controlled as the situation demands (BBC 2010).

Tracking vehicles

GPRS/GSM/GPS systems like LoCATe, V-SOL, Quartix, etc. regularly transmit pulsed radio signals using mobile phone technology whilst you are driving around. These systems help the police to locate the car quickly if it gets stolen. It is likely to be wired into a roof aerial, so does not bombard the car occupants with microwaves as much as a mobile phone in the car would. Microchips may be installed in all new cars to enable police to track speeding and other wanted vehicles.

A new 'pay as you go' scheme was being trialled, in which cars will have black boxes installed allowing their movements to be tracked by satellite. The motorists will then receive a monthly or weekly bill varying according to when and where they have travelled. They may have to pay up to £1.30 a mile during peak periods on the busiest roads. It is not known whether this will replace existing motoring taxes or be introduced on top of them (Telegraph 2008). The take up of the 'black boxes' has been very low. The EU has ruled that by October 2015 all new cars and vans sold across Europe must be fitted with this technology (eCall) which is designed to help emergency services find crashed vehicles and to otherwise track drivers' movements. Some car manufacturers, including BMW and Volvo, include eCall devices in their latest models. An SOS button near the dashboard linked to a SIM card, allows drivers to call 999 quickly. And if airbags are deployed it automatically sends a text message to emergency services with the car's location, as well as its unique vehicle ID number.

The RF emissions for other road users will be increased by a little, but it is not yet known what exposure will be experienced by 'black box' owners. Motorists will be unable to switch it off and it will be tested in MOT checks.

When your car lock doesn't work

The Dolphin TETRA mobile communications system is known to be able to interfere with vehicle electronic locks and alarms. This is because the Government issued Dolphin with frequencies very close to those used by car-locking and alarm systems. Unfortunately, car electronics are unable to reject the relatively powerful and pulsing Dolphin signals which therefore end up 'jamming' some cars' electronic locking systems. There were about 1000 Dolphin TETRA base stations around the UK. The Dolphin network failed to attract enough customers and was sold cheaply to UK Broadband during 2004. The future of these base stations is now in question but some areas are likely to remain active and may be sold to users such as bus, transport and security companies.

Some types of equipment on Ministry of Defence property give off microwave radiation. Fylingdales has been in the news because it was creating signals which interfered with car-locking devices, resulting in problems with people getting into their cars to leave.

Visitors to Windermere (Windermere Daily Mail February 2010) found that their cars would neither lock nor unlock when close to a restaurant using a wireless order taker. The frequencies used by the key fobs and the order machine were similar enough to interfere with the comparatively weak signal from the cars' key fobs. The restaurant's devices were reprogrammed to avoid the problem.

Driverless vehicles

In July 2014, the UK government announced that driverless cars will be allowed on public roads from January 2015. UK engineers have been experimenting with driverless cars, but concerns about legal and insurance issues have so far restricted the machines to private roads. Changes will be made to the Highway Code, which applies to England, Scotland and Wales. It is not clear how the developing new technologies used by a range of manufacturers will impact on the EMFs experienced both within vehicles and next to the roads where these new vehicles will travel.

Road trains

The BBC reported in November 2009 that 'road trains' are to be trialled in Europe in an attempt to cut fuel consumption, journey times and congestion. The lead vehicle would be handled by a professional driver, leaving the following vehicle occupants free to relax. Each vehicle would have its own control and software monitoring system. The 'platoons', which are likely to include trucks and cars, will be active so vehicles can join and leave as they need.

An alternative system to achieve these goals by wiring up motorways with wireless sensors would be too expensive.

If this system is implemented on UK roads, all cars may come fitted with wireless potential to be a part of the road train system, in an attempt to reduce fuel consumption and excess speeding, adding to the RF exposure experienced by passengers.

There are plans to set up Intelligent Transport systems throughout Europe. The benefits include less congestion and fewer accidents. *“If you're driving on an icy road, in future your car will automatically give this information to other drivers who use the same road,”* said a spokesperson for the public-private partnership ERTICO-ITS which is developing intelligent transport systems and services.

Charging electric vehicles

The Nissan LEAF electric car has its features controlled by a smartphone. Air conditioning and cockpit temperature can be programmed; you can check the battery levels and set the vehicle to send a message to say it has full power if you left it charging. The navigation system provides an up to date list of public charging spots. The car has a 100-mile range and a top speed of 90 mph (Daily Mail 2010).

Wireless charging of electric vehicles starts automatically when the car is driven over a pad containing an induction coil which charges the coil in a pad in the body of the car.

Controlled electric vehicle charging can reduce associated generation costs by 23%-34% in part only by shifting loads to lower-cost, higher-emitting coal plants. This shift results in increased costs of health and environmental damages from increased air pollution. Controlled charging of electric vehicles produces negative net social benefits but could have positive net social benefits in a future grid with sufficient coal retirements and wind penetration (Weis 2015).

Mobile phones

In a study by Joseph across 5 European countries (2010), the highest total personal RF exposure was measured inside transport vehicles (cars, trains and buses). This was mainly due to mobile phone handsets. The maximum SAR induced for mobile phone users in a vehicle is 5% higher than those in free space. The SAR values around the non-users body varied a lot in different situations and were higher than those in free space, in some circumstances (Leung 2012).

Car drivers have not been allowed, by UK law since 2003, to use a hand held mobile phone whilst driving. They must stop to do so, or they must use a hands-free kit. A study by Strayer & Johnston (2001) reported that, in a simulation experiment, those engaged in mobile phone conversations missed twice as many traffic signals as when they were not talking on the phone and took longer to react to the signals that they *did* detect. Most interestingly, there was no difference between hand-held and hands-free mobile phone users and it is thought that concentrating on a conversation with an unseen person is the main problem. He (2014) found that both speech-based communication and handheld text entries impaired driving performance by causing more variation in speed and lane position. Handheld text entry also increased the brake response time an increased variation in headway distance. In a review and meta-analysis by Ferdinand and Menachemi (2014) of the literature examining the detrimental relationship between driving performance and engaging in secondary tasks, they found that studies examining mobile phone use while driving were 16% more likely to find such a relationship.

Oommen & Stahl (2005) and Atchley & Dressel (2004) suggested that holding a phone to the ear, and the subsequent reduced freedom of head movement, limiting visual awareness may be at least partly responsible. Törnros & Bolling (2005) conducted a study in which many aspects of driving were changed by mobile phone dialling and conversation which were likely to increase the risk of accidents. Miller (2012) carried out a twin study in which mobile phone use seemed to be similar in twins. The authors suggested that this may have implications for assessing risks of driving accidents where one twin has been involved as driver.

Centers for Disease Control and Prevention (2013) reported that the prevalence of talking on a mobile phone while driving at least once in the past 30 days ranged from 21% in the UK to 69% in the United States, and the prevalence of drivers who had read or sent text or e-mail messages while driving at least once in the past 30 days ranged from 15% in Spain to 31% in Portugal and the United States. In an observational study of driving distractions in Spain, younger drivers and to a lesser extent middle-age drivers, were more frequently observed talking on a handheld mobile phone, and texting or keying numbers. The authors (Prat 2015) suggested that a substantial number of the drivers, especially younger ones, were putting themselves at an increased risk of becoming involved in a crash by engaging in non-driving related tasks at the same time as driving.

In Kuwait 51.1% of adult drivers always or almost always used a mobile phone when driving and 32.4% texted or sent SMSs (Raman 2013). In Mexico, 11% used a mobile phone while driving. People were more likely to use a phone if they were alone on major roads in non-taxi cars during the weekdays (Vera-López 2013). The odds of a driver using a handheld phone while traveling alone was over 4 times higher than for a driver traveling with passengers (Wundersitz 2014). Taxi drivers in Mekelle Town, Ethiopia were more likely to have a road traffic crash if they received a mobile phone call while driving (Asefa 2015).

However, any conversation (including with a passenger) was found to affect reaction time in a simulated condition (Consiglio 2003); even the ringing of a phone affected complex reaction time and quality of a performed task (Zajdel 2012). In a study by Haque & Washington (2014) the reaction times of drivers were more than 40% longer in the group using a phone. The impairment was almost double for those with provisional licences. A reduction in the ability to detect peripheral traffic events whist distracted presents a significant safety concern. Text messaging whilst driving has a negative impact on simulated driving performance. This impact appears to exceed the impact of talking on a mobile phone whilst driving. Participants responded more slowly to the onset of braking lights and showed impairments in forward and lateral control compared with a driving-only condition. Text-messaging drivers were involved in more crashes than drivers not engaged in text messaging (Drews 2009), 'heavy' texters being almost twice as likely to be involved in a collision resulting in orthopaedic trauma injuries. Thapa (2015) found the distraction and subsequent elevated crash risk of texting while driving linger even after the texting event has ceased.

Crash risk was strongly associated with heightened anticipation about incoming phone calls or messages among compulsive phone users (O'Connor 2013). Young (under 25), heavy (more than 30 texts a week), texters were nearly 7 times more likely to be involved in such an accident (Issar 2013). Cazzulino (2014) also found that young drivers were an at-risk group for distracted driving. Using a mobile phone whilst driving persists even when children are passengers in the car, putting them at risk (Roney 2013).

The increase of distracted driving behaviour has resulted in an increase in injury and death. A study by Hoff (2013) indicated that people fail to perceive the dangers inherent in distracted driving. 63% of drivers believed that they could drive safely while distracted, despite the fact that 9% of the drivers surveyed reported being involved in a car accident while distracted. The highest reported frequency of distracting behaviour included mobile phone use was 69% of study respondents. Despite the increased awareness on the dangers of texting and mobile phone use while driving, these specific activities were 2 of the most frequently observed distractions. Drivers less than 30 years old were texting/dialling more frequently than drivers aged 30-50 and more than 50 years old (Huisingh 2015).

In a study by Farmer (2015) monitored drivers were talking on a mobile phone 7% of the time, interacting in some other way with a mobile phone 5% of the time, and engaging in some other secondary activity (sometimes in conjunction with mobile phone use) 33% of the time. In another study by the same team (2015), drivers spent 11.7% of their driving time interacting with a mobile phone; primarily talking on the phone (6.5%) or simply holding the phone in their hand or lap (3.7%). The risk of a near-crash/crash event was approximately 17% higher when the driver was interacting with a mobile phone, due primarily to actions of reaching for/answering/dialling, which nearly triples risk.

Dialling or texting on a mobile phone, passengers, and in-vehicle sources resulted in an increase in likelihood of more severe injuries for young and mid-age drivers. Talking on a mobile phone had a similar effect for younger drivers but was not significant for mid-age drivers. For older drivers, the highest odds of severe injuries were observed with dialling or texting on a mobile phone, followed by in-vehicle sources and talking on the mobile phone (Donmez & Liu 2015).

A UK study (Sullman 2015) found that younger drivers are more likely to drive distracted (including talking on a handheld or a hands-free mobile phone), which probably contributes to their higher crash rates.

In a study of driving behaviour in a traffic simulator (Stavrinos 2013), distraction (in most cases, text messaging) had a significantly negative impact on traffic flow, such that participants exhibited greater fluctuation in speed, changed lanes significantly fewer times, and took longer to complete the scenario. In turn, more simulated vehicles passed the participant drivers while they were texting or talking on a mobile phone than while undistracted. The results indicate that distracted driving, particularly texting, may lead to reduced safety and traffic flow, thus having a negative impact on traffic operations.

Taking some antihistamines has an added effect when a mobile phone is also being used on brake reaction time, and could increase the likelihood of having an accident (Tashiro 2005).

53% of new university students report that they text more than 50 times a day. 24% report they text more than 100 times a day. 73% report they text while driving, and 92% believe that texting affects their concentration while driving (Buchanan 2013).

Using any sort of phone while driving a vehicle slows the driver's reaction time by about as much as being just over the UK drink-drive limit. The government has issued a leaflet about driving with mobile phones, www.thinkroadsafety.gov.uk/advice/mobilephones.htm.

One of the few effects of using a phone (whether mobile or hands-free) in a car that is accepted by ***all*** researchers, is that it increases accidents. Recent estimates suggest that some mobile phone users use 60% of their mobile phone time when they are driving. Microwave exposure is not only associated with concentration problems, but also mood changes. Using phones in cars may be responsible for the increase in road rage as well as accidents. Asbridge (2013) found crash culpability was significantly associated with mobile phone use by drivers, increasing the odds of a crash for which they were responsible by 70%. The risk was especially high for middle-aged drivers.

In a questionnaire study by Korpinen and Pääkkönen (2012) they found that 13.7% of respondents had close call situations and 2.4% had accidents at leisure, in which the mobile phone had a partial effect, and at work the amounts were 4.5% and 0.4% respectively, during the last 12 months. The authors found that: (1) men tend to have more close calls and accidents while on a mobile phone, (2) younger people tend to have more accidents and close calls while on a mobile phone, but it does not appear to be large enough to warrant intervention, (3) employed people tend to have more problems with mobile phone usage and accidents/close calls, and (4) there was a slight increase in mobile-phone-related accidents/close calls if the respondent also reported sleep disturbances and minor aches and pains.

In 2009 the National Highway Traffic Safety Administration (NHTSA) estimated that there were nearly 6,000 distracted driver fatalities and 515,000 injuries in the United States alone. Software is available to disable mobile phone use while driving, but using the advanced technology may require legislation along with a renewed sense of driver responsibility (Dildy Jr 2012). Teen drivers are most susceptible to the dangers of distracted driving, such as using a mobile phone, as is made evident in the over-representation of teens in distraction-related motor vehicle crashes (Adeola & Gibbons 2013).

Distracted drivers (including those distracted by the use of mobile phones) were found to be the cause of an increasing share of fatalities found among pedestrians and bicycle riders (Stimpson 2013).

Despite the proliferation of laws in the USA limiting drivers' mobile phone use, a study by McCartt (2014) found that it is unclear whether the restrictions are having the desired effects on safety. Distracted driving activities are common among drivers of child passengers. More than 75% of participants in a study by Macy (2014) reported mobile-phone related distractions. These were associated with the child riding daily in the family car, non-Hispanic white, and higher education.

Microwave radiation can be reflected from metal surfaces. Although passengers can quite legally use a mobile phone in a car, it is not a good idea. All the people in the car, including the driver and any children, will not only be radiated by the phone being used, but also by radiation reflected off the metal surfaces of the car. This will also happen when the phone is in standby mode, as it will be communicating (at full power) with base stations as you travel through different areas to ensure continuity of signal. This can happen as frequently as several times a minute, especially in areas of uncertain or poor signal strength.

One way of preventing microwave exposure being increased by reflections off the inside of cars is to install a hands-free kit with an aerial outside the car. Aerials inside the car will be nearly as bad as no aerial at all.

One man, in a personal communication, says "*I had an aerial for the handsfree, by the window, also acting as a tax disc holder (professional handsfree installation). I used to feel a bit ill while driving even with the phone on standby, and thought the aerial might have some part to play. Having moved the aerial to the roof outside, the illness (kind of headache) seems to have disappeared, and the level on the (microwave) monitor is medium when a call is in progress (was high field). I also have a fibreglass bodied car (with glass sunroof) and the levels were high all the time wherever the phone was placed, though I expect the signals bounce off the body etc. The signals from the masts can be picked up while driving past masts at speed on the motorway.*"

If you really HAVE to use a phone in a car or on a train or bus, it is best to hold the phone as close as possible to the nearest window. Remember that when the phone is partially screened from the base station (by the car or train body) then it will work at a much higher power than if you used it in the same place but outside the vehicle.

Motorbikes

The prevalence of mobile phone use among motorcyclists in Mexican cities was 0.64% (Pérez-Núňez 2014); it was highest among motorcyclists not using a helmet (1.45%) and those riding on 1-lane roads (1.6%).

Speed-limiting devices

New speed-limiting devices will use satellite positioning to check a vehicle's location and when its speed exceeds the limit, power will be reduced and the brakes applied if necessary (BBC report December 2008). The government's transport advisers claim the technology would cut road accidents with injuries by 29%. There would also be a positive impact on emissions and fuel consumption. As long as this technology is optional, and people with ES can opt out of its use, any RF exposure using satellite positioning, will be very small and only affect the car's occupants during transmission, which could be continuous. The satellite emissions themselves will be very small to the general public.

A spokesman for road safety charity Brake said: "*Ideally Brake would like to see compulsory mandatory ISA* (Interactive Speed Adaptation devices) introduced in the UK to physically stop drivers from breaking the speed limit."

In Lancashire, motorists were given free sat navs which inform them of speed limits. It was suggested that drivers sometimes speed when they are simply unaware that the limit has changed. Campaigners at the institute of Advanced Motoring (IAM) reckon that sat nav systems could reduce road deaths and injuries by as much as 29% on the county's rural roads. It was felt that, if successful, insurance companies may reduce premiums for drivers.

Traffic control sensors

Car sensors for traffic control usually use under-the-road magnetic field induction loops which are not an EMF hazard. Temporary traffic lights use microwave doppler units which point directly at the passing cars and usually in through the windscreen of the first car in the queue. Unless you make a habit of stopping in this position, this will not be a problem for most people as the power in the microwave beam is very low. It can, however, affect electrically sensitive people.

Other in-car devices

We have heard about a small in-car device that gives advance warning of traffic congestion on motorways and other large roads. Its name is suffixed by '1800', the frequency it receives as the carrier for this information. The device itself is just a receiver, and does not present a hazard. We expect that the transmitters will, by and large, use already existing mobile phone masts by the side of roads. However, the more gadgets we have that use microwave-transmitted information, the more our air is polluted by high-frequency electrosmog.

A young man who wanted to reduce his large car insurance premium fitted a box into his car that would allow the car insurance company monitor his driving times (he had agreed not to drive between 11 p.m. And 5 a.m., the time when many young drivers have accidents) and the box would communicate with his insurer if he drove when he was not supposed to.

The new car tracking devices that may be introduced in order to impose car tax according to road use is basically a GPS box with a GPRS interface to the mobile phone network. It radios back the position every time the car moves about 100 metres. There is no external antenna and the unit is usually dashboard mounted so the driver is sitting next to a series of phone calls being made almost continuously whilst driving along.

The emergence of Body Sensor Networks (BSNs) constitutes a new and fast growing trend. BSNs are to be integrated with Vehicular *ad hoc* Networks (VANETs). The development of this system will include : (1) an exhaustive review of the current mechanisms to detect four basic physiological behaviour states (drowsy, drunk, driving under emotional state disorders and distracted driving) that may cause traffic accidents; (2) A way to communicate with the car dashboard, emergency services, vehicles belonging to the VANET and road or street facilities; and (3) an Android real-time attention low level detection application that runs in a next-generation smartphone is to be developed (Reyes-Muñoz 2016).

In a study by Beede & Kass (2006) driving performance was measured in terms of four categories of behaviour: traffic violations (e.g., speeding, running stop signs), driving maintenance (e.g., standard deviation of lane position), attention lapses (e.g., stops at green lights, failure to visually scan for intersection traffic), and response time (e.g., time to step on brake in response to a pop-up event). Performance was significantly impacted in all four categories when drivers were concurrently talking on a hands-free phone.

Interference with electric vehicles

Electromagnetic fields, such as those generated by radio and television transmitters, and cellular phones can influence the functions of electric vehicles. Also, the electronics used in our vehicles can generate a low level of electromagnetic interference, which however will remain within the tolerance permitted by law.

- Do not switch on or operate portable transceivers or communication devices (such as radio transceivers or cellular phones) when the vehicle is switched on.
- Avoid getting near strong radio and television transmitters.
- In case the vehicle should be set in motion unintentionally or the brakes are released, switch it off immediately.
- Adding electrical accessories and other components or modifying the vehicle in any way can make it susceptible to electromagnetic interference. Keep in mind that there is no sure way to determine the effect such modifications will have on the overall immunity of the electronic system.
- Report all occurrences of unintentional movement of the vehicle, or release of the electric brakes to the manufacturer.