Introduction to Low-EMF Cars

Today's cars expose the driver and passengers to high levels of electromagnetic radiation. This article discusses the basic issues, points out the various sources of the radiation and links to helpful resources.

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The radiation problem

Cars and trucks contain many sources of radiation that can affect sensitive people riding inside. The symptoms vary with the person. Some become irritable (and perhaps more likely to get "road rage"), some get headaches, joint pain or other aches. In rare cases, people are so sensitive they feel burning sensations in their legs, hands or chest and may not be able to drive a car or even be inside one.

Health effects from electromagnetic radiation are controversial and hotly contested by special interests, though literally thousands of independent scientific studies support their existence (see the BioInitiative reports for summaries). This author is not aware of any scientific studies that specifically looked at health effects from vehicle radiation. Presently, there is only anecdotal evidence. This author has met about two dozen people who were so sensitive to car radiation that they were unable to drive themselves. Many are more mildly affected. For a personal account of these problems, see the book listed at the end of this article.

Sources of radiation

Modern vehicles have a myriad of radiation sources, and more will be added in the future. Older vehicles, from before about 2005, had much fewer sources.

There are three general categories of radiation:

- extremely low frequency
- low frequency
- radio frequency

Some people are sensitive to only certain frequencies, or certain categories of frequencies (as shown by a 1991 experiment by Dr. William Rea).

In the following we'll list the various radiation sources. It is important to be aware of them when trying to lower the radiation or looking for a safer vehicle.

Extremely low frequency magnetic radiation

The main source of extremely low frequency radiation in a car is the alternator, which generates electricity that charges the battery and powers everything in the car. The alternator produces 12 volt DC electricity in most vehicles (24 volt DC in large trucks). The DC electricity from an alternator is "dirty," i.e. it has a lot of "spikes" or "transients" in the flow of electricity. This makes the wires in the vehicle radiate, which can be very bothersome to sensitive people. Wires going to the battery and other parts that use a lot of electricity will radiate the most. Many vehicles have a wiring harness inside or below the dashboard, which is close to the driver and can cause symptoms.

Some luxury cars have a backup battery in the trunk with a wire passing under the car, which can be a problem. We have seen this on Mercedes cars.

The fuel tank is always located in the back of the car. Most cars have an electric fuel pump in the tank. The pump motor, and the wire going to the pump, can be a problem. Some older cars have engine-driven fuel pumps that do not radiate.

There is usually an electric fan mounted on the front of the engine radiator. This fan comes on if the engine is overheating on steep mountain roads, or if idling on a hot day. A few cars have transverse mounted engines, which require such a fan to be on all the time. Engine fans can generate very powerful EMF; this author has measured 100 milligauss (10 uT) at the driver's seat from such a fan.

There is usually a small ventilation fan mounted inside the dashboard. It is used when the air conditioning is on, or for simple ventilation. It is small, but can be a problem since it is so close to the front seat.

When the headlights and tail lights are on at night (and when braking) a lot of dirty electricity will run to them from the alternator, and radiate off the wires. This is especially a problem when the wires run close to the driver or passenger.

All normal tires have steel belts just below the tread. These steel belts usually become magnetized during manufacturing. When the wheels are turning, this magnetization will create low-frequency radiation (just as it does inside an alternator or a power plant generator).

Newer cars have tire pressure monitors mounted on the valves. These monitors contain a small magnet to generate electricity to power the electronics, when the wheel is turning.

Some cars have a magnet inside the transmission, or on every wheel, that generates pulses to measure the speed (see later).

Some people with MCS install air cleaners powered from the cigarette outlet. The DC motors in these air cleaners often radiate powerful magnetic fields.

All these sources of extremely low frequency radiation can be measured using a gaussmeter. Turn on the engine and move the meter around while the car is parked. Make sure to measure all places where a person would be, including the feet, hands and head. Pay particular attention to the foot well, the front of the dashboard, the seat and where the head would be.

Then get someone to drive the car, while you measure the car again. This should reveal problems created by the tires, tire monitors, speedometer, anti-lock brakes, etc.

Lower frequency radiation

Gasoline engines use spark plugs. Spark plugs ignite the fuel with little electrical sparks many times a second. The first radio transmitters a hundred years ago used the same principle, where they were called "spark gap transmitters." The spark plugs are powered using an ignition coil, that also radiates.

In modern cars the fuel is vaporized using electronic fuel injectors (older cars used carburetors or mechanical fuel injectors).

Today's vehicles can have about a hundred microprocessors throughout the vehicle. There will also be voltage converters and other radiating electronics.

Electric cars and hybrid cars will have battery chargers and power management electronics radiating in this frequency range.

Electric motors, such as in fans and fuel pumps, will also radiate in this frequency range, as well as in the extremely low-frequency range.

A gaussmeter is not the right tool for measuring these frequencies (about 500 Hz to 1 MHz). It may pick up the lower of these frequencies, but only a quality instrument will give an accurate reading. There are presently no consumer grade instruments for this purpose, but a handy tool is to use an AM radio. Set the dial at the lowest frequency, where no station can be heard. Then move the radio around the car and listen to the crackle in the speaker.

Radio frequency radiation

Vehicles did not use to generate any radio frequency radiation at all, except for a little bit coming from the spark plugs. Today's vehicles routinely bathe the driver in radio frequency radiation above 100 uW/m^2 and sometimes more than 1000 uW/m^2, just from the built-in equipment. In addition, when people use mobile phones or other wireless gadgets inside a car, they will be exposed to much higher levels than if they used them outside the car. This is because the steel plates of the car reflect the radio waves that bounce around inside. And since the mobile phone has trouble reaching the base station, it will ramp up the signal strength, too.

Some cars have a built-in Wi-Fi "hot spot" that radiates whether it is used or not.

There may also be a built-in cellular transmitter for emergencies, such as the OnStar system, or to tell the owner of the car (i.e. rental company or fleet-owning corporation) where the car presently is.

Newer vehicles have ever more safety devices to prevent crashes. These include radars mounted on the front and back (hidden inside bumpers or behind plastic panels) and backup cameras. In the future there will also be V2V (vehicle-to-vehicle) transmitters where each vehicle wirelessly informs other vehicles about its position, speed and direction.

An RF meter is needed to measure all these RF sources, though since they transmit in brief pulses most meters will not be able to give an accurate reading. A work-around is to place the RF meter on a tripod and program it to record the MAX reading over several minutes.

The speedometer

Older cars have a flexible speedometer cable that goes from the transmission up to the dashboard where it powers a mechanical speedometer and odometer. These are benign.

In the 1980s some manufacturers started to install a magnetic sensor in the transmission that generates electric pulses. The faster the car moves, the more pulses per second. These pulses are carried by electric cable to the dashboard, where electronics convert the pulses to be displayed by the speedometer and odometer.

The cables carrying these pulses radiate low-frequency magnetic radiation that can be measured by a gaussmeter and be a problem if passing near a sensitive person.

Some of the early electronic speedometers (such as used in the Mercedes 300SD) used a mechanical pulse-reader in the speedometer. Newer models use a computer to count the pulses and calculate the vehicle’s speed.

Anti-lock brakes

Cars with anti-lock brakes (ABS) have magnetic sensors on each wheel to detect when the wheel is not turning (i.e. locked when braking on an icy road). They work very similarly to the electronic speedometer described above and the cables radiate the same way.

Cars with anti-lock brakes usually use the pulses from one of the wheels to measure the speed as well. Cars with traction control use the pulses to detect when a wheel is spinning on an icy road.

With pulsing cables going from all four wheels, it may not be possible for a sensitive person to sit anywhere in such a car, including on the back seat.

The wireless key

All modern cars have a wireless ignition key of sorts. There are two basic types: the RFID key and the smart key.

The RFID key is the most common. It was invented by Ford Motor Company in 1997 and was soon adopted by most other manufacturers. The RFID key has a small chip embedded in the plastic handle. When turning the key in the ignition, a brief radio signal is sent out from the dashboard. The RFID key has a tiny antenna that harvests some of that radiation and uses it to power up the RFID chip, which then sends out a brief radio signal with a serial number. If the serial number is correct, the car will start. (If not correct, the car may still start, but will soon stall.)

This whole sequence takes less than a second, so the radiation exposure is very brief and should rarely be a problem.

The technology is similar to those security gates at the exit of some stores to prevent theft.

To check whether a key is RFID, try to wrap the plastic handle in aluminum foil. It will block the wireless communication with the key so the car can't be started (or it may run briefly).

The smart key system (also called "keyless entry") is much worse than the RFID key, as it radiates as long as the car is turned on. The smart key allows the car to be turned on without any key in the ignition at all. The driver just needs to keep the "key" in a pocket or purse. The car is started by pushing a start button on the dashboard; no turning of any key is needed. The system otherwise works like the RFID key, but since the smart key is much further away from the dashboard, the radiation has to be much stronger to power up the little key fob. Also, since the smart key is not in any keyhole, the car will have to keep checking wirelessly that the key is still present. Hence the continuous radiation as long as the engine is on.

We measured such a system in a 2016 Nissan Sentra. The radiation exposure to the head of the driver was about 1800 uW/m^2 every ten seconds or so (and around 500 uW/m^2 the rest of the time).

The smart key system also allows the doors to be unlocked automatically. When the handle is pulled, an antenna on the side of the car transmits a brief signal to the smart key. The car then unlocks. This part of the system transmits just briefly and should not be a problem to people near the car.

Siemens and Mercedes-Benz developed the smart key system in the late 1990s. Other car manufacturers adopted similar systems later on. It is now commonly used by both American, European and Japanese manufacturers. Each manufacturer has a different name for it, usually including the words "smart," "keyless" or "intelligent."

It may be easiest to ask if a car is started by pushing a button, or if a key must be inserted and turned.

The details are kept secret to deter theft, but one source claims the cars transmit at 125 kHz, while the key fob responds at 300 MHz.

Some smart keys have a battery in the fob, while others are fully powered by the radio signal from the car.

Wirelessly networked cars

Some vehicles have a built-in wireless network that connects the car with the internet through cellular base stations. It offers wireless Wi-Fi services to the passengers inside the car, while in the future it will also be used to keep track of where the car is, report emergencies, etc. Some industry analysts expect this to be standard on most car models by 2020.

Add-on radio frequency sources

A number of toll roads and bridges in Europe, the United States and elsewhere use an RFID type decal to register when passing the toll gate. The decal has no battery and is inert except when passing through a toll gate, where it picks up radiation from a powerful transmitter, briefly powers up, sends out its serial number and then goes dormant again. That whole process takes less than a second and is so brief most sensitive people are not affected. This is similar to the anti-theft gates in some stores.

Some states and countries are considering taxes based on which roads are used and at what time of the day. This is called road-pricing. It should help reduce traffic congestion and replace the dwindling fuel taxes (due to electric cars). The problem is that it will likely require the installation of wireless equipment in each vehicle to report where the vehicle is at all times. (This technology also has some obvious privacy issues.)

Electric and hybrid vehicles

Hybrid vehicles are essentially electric vehicles with a gasoline-powered electric generator added on, so they can have a smaller battery. The following apply to both hybrid and full electric vehicles.

The wheels are powered by one or more electric motors. There is usually one electric motor under the hood, but there could be one electric motor mounted directly on two or all wheels.

There are various types of electric motors available. The ones used today are mostly AC motors running at around 12,000 rpm. These motors will emit radiation mostly in the kilohertz range (i.e. not really measurable by a gaussmeter).

The motors act as generators when the brakes are applied, to send energy back to the battery instead of wasting it (called regenerative braking).

When the battery is charged (by plugging it in, using the onboard engine or when braking) the current is pulsed to improve charging. This pulsing creates powerful dirty electricity, also in the kilohertz range and thus underreported by a gaussmeter.

The radiation environment in a hybrid or all-electric vehicle is very different from a regular gasoline or diesel vehicle. It is difficult to correctly measure and compare with a regular vehicle.

The author once inspected a Toyota Prius hybrid car and had just a low-cost gaussmeter available. The gaussmeter gave an unremarkable reading when the car was sitting with the engine idling (charging). A brief test drive produced some profound symptoms, unlike any regular car. The author was unable to do any measurements while driving.

Electric and hybrid cars have so many problems that they should simply be avoided by sensitive people.

Self-driving cars

It will be many years before truly self-driving cars will be available, i.e. cars where no human needs to sit behind the wheel and be ready to take over in special situations. Once that actually happens, a sensitive person might be comfortable sitting on the back seat, further away from the drive train and electronics up front, but that is quite unlikely. The automated cars will employ numerous radiant technologies, including radars and wireless communication with other vehicles. It is also likely that they will use electric motors.

What to do

The options to consider are basically:

- Find a lower-EMF vehicle
- Sit elsewhere in vehicle
- Degauss tires
- Modify vehicle
- Use no vehicle

People have done all of the above, depending on their situation. Severely sensitive people may be able to tolerate a not-too-bad vehicle if they sit in the back seat (opposite side of the fuel pump).

Modifying an existing vehicle can provide only limited relief, especially with newer vehicles. Some people simply have to drive vehicles from the 1990s or even the 1980s. Even such older cars may need to be modified.

See the "More information" section below for more information on these options.

Will the old low-EMF cars be banned?

No government anywhere has ever banned any kind of vehicle before. The oldest cars are still street legal, even those produced without seat belts or any other safety features. They are all grandfathered in. This is likely to continue.

Even though some governments have announced that new non-electrical cars will not be legal to sell by a certain year, the existing cars will continue to be legal. However, some large cities are considering banning non-electric vehicles from their centers to control air pollution.

Cars kill about 30,000 people every year in the United States. The automated cars that can talk to other automated cars wirelessly should dramatically reduce the number of accidents. Cars that do not have the wireless transponders and have a human in control will be much less safe to have on the road. Governments may offer various incentives to get them off the road, just as they have done to get old polluting cars retired (such as the "cash for clunkers" program in the United States). Insurance companies will surely penalize drivers of the old "unsafe" cars by demanding higher insurance rates.

But there are too many people who'll want to continue to use the old cars. Old cars are much cheaper to buy than newer vehicles, and they are also cheaper to repair, as they do not require a specialized high-tech repair shop. People in rural areas may also have no access to ride-sharing so they must have their own vehicles.

Then there are all the car enthusiasts who just love the old cars, especially once the drivers of new cars will no longer be in control of the wheel. Car enthusiasts will surely block any law limiting their driving pleasures.

Legal accommodations

A few countries require all cars to have their headlights on during the day, to improve their visibility. Since headlights use a lot of electricity, that makes it difficult to comply for some sensitive people. In Sweden people with electrical sensitivities are exempt from the always-on law.

In the future, some countries may mandate that all vehicles have a V2V transmitter sending out the car's position, direction and speed to aid self-driving cars. Insurance companies may exact heavy penalties on drivers without such a transmitter.

People with EHS may get exempted from such a law, but may not avoid the insurance companies' penalty. If the insurance company allows anyone to opt-out, then a court may not consider the penalty discriminatory.

Another possibility

Several people with electrical sensitivity are also noise sensitive. Noise simply gives them symptoms that can even be identical to the symptoms they get from EMF exposures. It may help to use heavy-duty ear protectors such as those used by operators of heavy machinery (simple ear plugs do not work for low-frequency rumble).

More information

See www.eiwellspring.org/vehicle.html for articles about mitigating the radiation in a car or finding a lower-EMF vehicle.

The book *Chemical and Electrical Hypersensitivity: A Sufferer's Memoir* by Jerry Evans (McFarland, 2010) details one person's battle with his car and how he ultimately succeeded.

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