

From: Dr. Ronald N. Kostoff

To: EMF Health Effects Distribution

Subj: Automotive Radar

## BACKGROUND

Non-ionizing radiation has become ubiquitous in our daily lives, and is expanding rapidly. One of the least appreciated sources/environments is the cabin of modern-day vehicles. There are myriad non-ionizing radiation sources originating within the cabin and entering the cabin, and probably the least recognized is automotive radar. The following discussion addresses only a few aspects of this potentially toxic stimulus.

## PERSONAL INTEREST

I'm in the process of looking for a replacement car. One of the criteria is minimum exposure to RFR and ELF-EMF. I've made some measurements in the cabin of candidate vehicles at power frequencies and cell phone/WiFi RFR frequencies. Given the commonality of Bluetooth and other RFR sources even in base low-tech models, I have found that RFR readings in the cabin are non-negligible. Additionally, some ELF measurements I've made in one hybrid showed magnetic fields can be high near the driver's head and even lower body. I've read about other hybrid ELF measurements where highest readings occur at other seating positions, and, over the past decade, have read about non-hybrid (gasoline-only) vehicles where high ELF readings have been recorded.

## AUTOMOTIVE RADAR

However, there is another wireless radiation problem that seems to be relatively overlooked. Many new cars routinely include a suite of 'safety' sensors even in the lowest-tech base model. Many of these sensing devices emit radar. I don't know how much of the radar radiation feeds back into the cabin from the sensors installed today. Hopefully none, but that may depend on the beam spread characteristics.

However, the outward radar beams travel for substantial distances, and can impinge on other cars and pedestrians. While the metal surrounding the target car should be able to block the impinging radar, the glass will be transparent to many radar frequencies. I don't know about penetration/absorption in non-metal composite car structures.

The radar radiation adverse effects problem could be serious. Unfortunately, I haven't found anything on the Web (other than hand-waving) that shows quantitatively how much radar radiation flux could be impinging on car passengers/drivers and pedestrians. Additionally, I haven't found portable meters that could measure the magnitude of the radar signals at the automotive radar frequencies (~24 GHz and ~77 GHz). I'm both surprised and appalled at the lack of quantitative information about this potentially serious problem. If anyone can direct me to quantitative studies of automotive radar, and meters that would operate at these frequencies, I would be most appreciative.

## DELIBERATE IN-CABIN RADAR

In searching the Web for automotive radars, I recently came across some interesting articles on near-future applications of such radars. One such article is the following:

[https://www.eetimes.com/document.asp?doc\\_id=1333330](https://www.eetimes.com/document.asp?doc_id=1333330)

In this article, the statement is made:

"For example, the digital processing capability inside the mmWave sensor can filter out noise, said Wasson, allowing TI's radar chips to detect very small movements, even the breathing that indicates the presence of a person or animal inside a vehicle.

Wasson noted that "child occupancy detection" is likely to become a feature in the Euro NCAP roadmap. This, he believes, will open the door for TI's radars in body, chassis, and in-cabin applications. As tier ones and OEMs look for the right sensing technology to enable such detection possibilities, Wasson noted that radars are much better-positioned.

Radar, for example can "see" through a blanket to determine whether a child is underneath. TI's radar chips can even distinguish between a person and a static object like a duffel bag, explained Wasson, because their on-chip digital signal processing can detect a heartbeat."

The aim seems to be to ***deliberately radiate the cabin with radar RFR***, for various detection purposes. They make no mention about potential power levels.

I have seen other such articles where the radar would be ***aimed at the driver continuously***, to insure alertness and awareness. For example, consider the following article:

<https://www.cnet.com/roadshow/news/volkswagen-invests-100-million-to-develop-solid-state-battery-tech/>

In this article, the statement is made:

"Sudipto Bose, director of marketing for automotive radar at Texas Instruments, points out that in-cabin radar offers a number of benefits. It can alert parents if they've left children in a car, and it can be used for gesture controls, which let drivers control navigation, phone and stereo with hand motions. This proximity radar could also identify if a driver's attention is not focused out the windshield..... If automakers take Texas Instruments up on its new radar sensors, a production vehicle with radar-based gesture control would still be *two to five years away*."

The time frame is relatively short!

## **COMBINATIONS OF TOXIC STIMULI INCLUDING NON-IONIZING RADIATION**

**So, if you're driving a hybrid vehicle with a full load of passengers, you will be subject to:**

**\*ELF-EMF from the tires and other sources unique to hybrids (which I measured two weeks ago)**

**\*RFR from your cell phone and the cell phones of the other passengers**

**\*RFR from Bluetooth (which I measured a couple of weeks ago)**

**\*RFR from the WiFi 'hot spot' and the devices communicating with the hot spot**

**\*RFR from the myriad cell towers that dot the sides of most highways**

**\*RFR from the radar sensors of other cars**

**\*RFR from on-board radar sensors to detect motions and driver alertness within the cabin**

Almost all these radiation sources will also be operable in a gasoline-powered car, and there will be some bouncing around of the radiation within the cabin because of the surrounding metal.

Our studies on combinations of toxic stimuli including non-ionizing radiation showed the adverse health effects are exacerbated when non-ionizing radiations of

different characteristics are combined. I can only imagine the effects of the above complex combination! And, I'm not even sure I caught all the sources of exposure in the cabin. When we add in the combination of the non-ionizing radiation cocktail above with the surrounding air pollution, and the other toxic stimuli to which the occupants of the car are exposed in the car and in their daily lives, we have a very serious situation.

Also, it's not clear to me how the FCC exposure limits (which are already six orders of magnitude too high for protective purposes) would apply to limit in-cabin radiation levels. Would they apply to each source, or to the total radiation? I suspect the former. If that is the case, cabin occupants could be exposed theoretically to radiation levels well in excess of the present FCC limits.

#### PRIOR EMAILS WITH MORE DETAIL

I have appended three emails that I sent recently to another group addressing this issue. There were other emails in the correspondence thread that I didn't include, so they might appear somewhat disjointed.

The first email addresses an FCC directive allowing very high automotive radar exposures at all vehicle speeds, including idling. There used to be a requirement that the radar be powered down at vehicle idling, but the FCC directive (at Toyota's request) removed this requirement. So, as I point out, a small child walking across a crosswalk with rows of cars stopped for a light could theoretically be exposed to *a million microwatts/square meter, or more*, full body radiation, if the radars are operating at the FCC limit. I don't know how much today's automotive radars actually emit, since I have seen nothing on the Web about that and I don't have access to a meter that could make those measurements.

The other two emails amplify specific automotive radar issues further, including potential synergistic effects among automotive radar and Bluetooth and WiFi and ELF (which can occur in non-hybrid cars as well as hybrid), which can be operating simultaneously in a given vehicle.

These automotive radar frequencies are within the frequency range encompassed by 5G, so, in fact, we have already been implementing 5G-frequencies for the past decade. We've been focusing on the shell, and not the pea, or at least on one pea and not the other pea(s)!

RNK

## APPENDICES

### FIRST EMAIL

Per the automotive radar issue, I came across this interesting FCC directive from 2012.

<https://www.federalregister.gov/documents/2012/08/13/2012-19732/operation-of-radar-systems-in-the-76-77-ghz-band>

It appears that the FCC used to have a requirement that when cars were stopped, such as in a traffic jam, any onboard radars would have to reduce power to minimize longer-term exposure to humans. In 2009, Toyota applied to relax these rules, for reasons described in the linked document. Naturally, the FCC complied with the request.

What I find interesting is the emission limits they adopted.

"In lieu of separate emission limits for in-motion and not-in-motion, the Commission proposed to increase the average power density limit to  $88 \mu\text{W}/\text{cm}^2$  at 3 meters (average EIRP of 50 dBm) and to decrease the peak power density limit to  $279 \mu\text{W}/\text{cm}^2$  at 3 meters (peak EIRP of 55 dBm) for vehicular radar systems regardless of the direction of illumination."

In units I use, the average power density limit would be  $88 \times 10^4$  microwatts/square meter, or 880,000 microwatts/square meter, ***at three meters***. So, in slow moving traffic on a superhighway, if there was nine meters separation between the bumper of the car behind and the driver of the car ahead (a conservative estimate in bumper-to-bumper traffic), there could be as much as 220,000 microwatts/square meter radiating the driver/passengers of the front vehicle. I don't know how much would be absorbed by the glass at these frequencies, but I have seen some documents to the effect that some bands will penetrate the glass. There could also be side radar coming from cars other than the rear car.

If you're walking on a crosswalk in front of stopped traffic, you may even be closer than three meters to the bumper, and could be exposed directly full body to a million microwatts/square meter. And, there's no glass or metal to absorb or block the radiation. And, that's with the assumption that you're being radiated from one car only.

I don't know what the actual emissions are in today's cars. I would suspect they're quite high, but the actual numbers would be conclusive. Walking on today's streets in high traffic areas has become a dangerous pastime, and few people realize it!

## **SECOND EMAIL**

What we really need to get are the codes the auto manufacturers use to compute actual radar exposures to car occupants and pedestrians. There are geometric and obstacle issues that need to be taken into account, which were not included in the prior rough estimates. We need to know where specifically all the radars are located, what are their powers and antenna characteristics, how much radiation is blocked by a target car's trunk, hood, doors, etc. Also, how much passes through the windows, is absorbed by the windows, and is reflected by the windows.

The estimates for pedestrians are far more accurate. If they are walking in front of an idling car, they are getting pretty much unimpeded exposure. If some of the radars are mounted on the front bumper, then small children walking a crosswalk would be the most vulnerable. I don't know what the beam spread in the vertical plane would look like on these actual radar systems, but it wouldn't have to be much to provide full body exposure to small children.

So, people in a car are exposed not only to their cell phones/tablets and those of their fellow occupants, but also to Bluetooth and WiFi, in addition to the radar coming from other vehicles. If they have a hybrid, there could also be substantial exposures to ELF magnetic fields as well (as I-and others-have measured). What are the synergistic effects of being exposed to these myriad (radar, cell phone, WiFi, ELF, etc) non-ionizing frequencies simultaneously?

On route 66 in Virginia (a heavily trafficked superhighway near me), there are always repairs being done. The road gangs work only a few feet from the streams of traffic. In addition to their cell phones/tablets, they are exposed to radiation from the many cell towers that can be seen from 66, as well as to the radars from the cars that are whizzing by in close proximity. These exposures are almost continuous for eight hours a day. Again, what is the synergistic effect of these exposures to different frequency radiation.

And, of course, in highly congested traffic areas, there is the added bonus of high levels of pollution from the cars' exhausts. So, we get 2-for-1: EMF pollution and air pollution. What do those synergies look like? The arrival of 5G in these areas will be the icing on the cake. Given that radars operate at either 24GHz or 77GHz,

5G-frequency operation has essentially arrived in these areas. It's not coming from short cell towers, but rather ultra-short cars!!!

### **THIRD EMAIL**

Two other interesting points. In the FCC directive I sent yesterday, the radar exposure limits were based on radar emanating from one car. But, if there are multiple cars, with some emissions spreading to the side, then the cumulative exposures could be well above the FCC exposure limits at selected points.

Additionally, many people believe the driver should sit as high as possible, to be able to see the front of the hood and have a commanding view of the highway. This is something of a safety measure. However, now with potential radar exposures, sitting higher above the car beltline is akin to a soldier in the trenches exposing himself to potential sniper fire. To avoid radar through the windshield, or especially through open side windows, one should sit as low as possible. This increases safety hazards. Another unintended consequence, brought to you by your friendly wireless vendor and FCC Commissioner!

From: Dr. Ronald N. Kostoff  
To: EMF Health Effects Distribution  
Subj: Automotive Radiation

In response to yesterday's mailing on Automotive Radar, I received a number of informative comments. One that I would like to share (with the author's permission) is reproduced below. Dr. Metsis provides very useful detail about sensors and communications systems to complement yesterday's mailing.

While the picture presented below is quite disturbing, it should be emphasized this is one piece in the much larger toxic stimulus puzzle. Our book chapter on health effects of combined toxic stimuli including non-ionizing radiation (attached) makes clear that combinations of toxic stimuli have the potential to exert far more serious health effects than toxic stimuli applied in isolation. This derives from potential synergistic and additive effects.

A recent monograph on combined effects supports these conclusions (<https://smartech.gatech.edu/handle/1853/59719>). It states that "these combinations 1) typically lower the threshold constituent exposure levels associated with damage compared to 2) tests of combination constituents run in isolation.....there is no reason to believe today that ANY of the Exposure Limits on

potentially toxic stimuli that have been set by ANY of the regulatory agencies are fully protective against serious adverse health effects.

While radiofrequency radiation (RFR) is used for illustrative purposes in a number of the examples presented, the conclusions are applicable to essentially all potential contributing factors to disease amenable to Exposure Limits."

A follow-up monograph confirms the above conclusions and shows that we have essentially zero government protection from any of these toxic stimuli, including non-ionizing radiation

(<https://smartech.gatech.edu/handle/1853/60067>). Unfortunately, we have extremely limited data on test results from combinations of toxic stimuli, and what little data we have come mainly from combinations of two toxic stimuli. Real-world toxic stimuli exposures would include those listed by Dr. Metsis below, PLUS lifestyle, iatrogenic, biotoxin, occupational and environmental, etc, toxic stimuli exposures. So, for individuals exposed to many of the toxic stimuli in the categories above, and who may have genetic disposition to various diseases, the addition of the non-ionizing radiation toxic stimuli summarized by Dr. Metsis could be the final 'straw-that-breaks-the-camel's-back'.

RNK

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**From:** Theodore Metsis <[theodoremetsis@yahoo.com](mailto:theodoremetsis@yahoo.com)>

**Sent:** Monday, September 17, 2018 5:56 AM

**To:** Kostoff, Ronald N

**Subject:** Radiation in cars

I got your email from a colleague and I will attempt to pass some further and perhaps useful info

Modern cars namely 2018 models have high low-frequency radiation arising from many wireless sensors incorporated in today's automotive technology.

Attached is a drawing with most of these sensors you find in modern vehicles.

Depending on the wiring architecture inside the car, EMFs are more pronounced depending also on fuse box location, battery and alternator position and currents flowing close to the cabin.

EMFs in a car in motion with brakes applied + ABS activation may well exceed 100 mG. Adding RF radiation from blue tooth, Wi Fi, the cell phones of the passengers, the 4G antennas laid out all along the major roads plus the radars of

cars already equipped with, located behind, left or right of a vehicle, the total EMF and EMR fields will exceed any limits humans can tolerate over a long period of time.

EHS people are nowadays searching for pre 2000 models otherwise they cannot drive them and low frequency EMF is very difficult to shield.

In Sweden with more that 200000 EHS citizens there are special Navigation maps showing the roads these people have to follow avoiding cell phone base stations.

With the 5G application and V2V and V2I connectivity, the conditions inside the car will be appalling and this is why we will have autonomous vehicles because driving under these conditions cannot be sustained over a long period.

Cars in effect will be micro-wave ovens on wheels! The attached info is from two slides I use in my EMR presentation showing also statistics of car accidents in US, a good excuse for adding all these lethal gadgets to vehicles.

Kind regards

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