EMF Test of 2007 Toyota Prius Hybrid

Instrumentation

AC Gaussmeters

ELF (5 Hz – 2 kHz):

- F.W. Bell 4090 (digital, triaxial, 40–400 Hz, 100 µG – 2 G)
- F.W. Bell 4080 (digital, triaxial, 25 Hz – 1 kHz, 100 µG – 511 mG)
- Holaday HI-3624A (analog, single axis, 5 or 30 Hz – 2 kHz, 100 µG – 20 G)
- Walker Scientific ELF-60D (digital, audio, single axis, 40–400 Hz, 100 µG – 20 G)
- Integrity Design & Research IDR-109 (digital, LED, audio, single axis, 54–66 Hz, 1 µG – 2 G)
- Gigahertz Solutions ME3030B (digital, audio, single axis, 16 Hz – 2 kHz, 10 µG – 20 mG)

VLF (2–300 kHz):

- Holaday HI-3603 (digital, single axis, 2–300 kHz, 12.5 µG – 25 mG)

Electric Field Meters

DC (plus or minus 0–50 kV):

- Simco FM300 (digital, 0–50 kV)

ELF (16 Hz – 2 kHz):

- Gigahertz Solutions ME3030B (digital, audio, single axis, 1 V/m – 2 kV/m)

VLF (2–300 kHz):

- Holaday HI-3603 (digital, single axis, 2–300 kHz, 1 V/m – 2 kV/m, 265 nW/cm^2 – 1 W/cm^2)

RF/MW Meters

General Microwave RAHAM 4C (analog, isotropic, 200 kHz – 26 GHz, 1 µW/cm^2 – 20 mW/cm^2)
Zapchecker ZC 180 (analog sniffer, LED, vibration, 10 MHz – 6 GHz)

Datalogger

Foxboro DL 332F

Results and Conclusions

There were a lot of misleading statements in the recent NY Times article – "Fear, But Few Facts, on Hybrid Risks" – including claims of 100 mG fields, which are causing alarm. The article is at (subscription required):

http://newsletters.environmentalhealthnews.org/t/11788/3913/14905/0/?u=aHR0cDovL3d3dy5ueXRpbWVzLmNvbS8yMDA4LzA0LzI3L2F1dG9tb2JpbGVzLzI3RU1GLmh0bWw%3d&x=c44e98fd

It's next to impossible to get accurate readings in a moving vehicle. Since there was no lift available to simulate road resistance to the drive train in a constant external EMF atmosphere, the results of this testing are only approximate at best. The AC magnetic field readings are the most reliable. DC magnetic field tests weren't feasible with the vehicle in motion through the earth's magnetic field, even with no other vehicles in the vicinity. RF/MW measurements were also impossible to precisely distinguish from external sources,

though more reliable when the vehicle was stationary and repeated readings were taken at the same internal location.

Regarding the NY Times article:

1. Trifield meters are useful, but it's important to be aware of their sensitivity to high frequencies when trying to determine ELF levels, and of the fact that standard Trifields, unlike most gaussmeters, are frequency-weighted. Higher frequencies read as higher magnetic fields. So a 120 Hz field will read twice as high as a 60 Hz field, a 180 Hz field three times too high, etc., and they have significant sensitivity as high as 100 kHz, and some residual sensitivity to 100 MHz – on the magnetic, not radio/microwave setting. This can result in wildly high readings if they're interpreted as ELF when higher frequencies are present (like near the floorboards of cars with electronic ignitions, which includes many more vehicles than just the Prius and other hybrids).

2. AC magnetic field readings were consistently higher on the rear seats than on the front seats. Measurements in the rear passenger compartment were made in the center of the seats, away from the doors, to avoid confusion with the ELF magnetic fields from the magnetized, revolving steel wires in the tires. Tire fields are too low-frequency to be detected by most gaussmeters, which have 30 or 40 Hz low-frequency filters to keep them stable while moving in the earth's field, but they're present in most if not all vehicles, even those with "polyester-belted" radials, which still have significant steel in them. They're usually confined to within a few inches of the back doors.

3. ELF magnetic fields were highest when both the gasoline engine and the electric motor were running – when the vehicle was warming up, accelerating, climbing even slightly, or charging the battery. During hard acceleration, they could reach 6 or 8 mG at seat level on the rear seats, diminishing higher up from the seats.

4. Operating on the electric motor alone, the readings in the back were usually less than 3 mG at seat level, diminishing upward to about 0.4 mG at head level. Average readings on the seats in the back under different driving conditions were around 2.8 mG.

5. At the surface of the back seats, the highest AC magnetic fields were found to be oriented perpendicular to the ground, but this may have been simply because the pickup coils could be held closer to the seats in that position.

6. At 60 Hz (actually between 54 and 66 Hz), levels were less than 1 mG at the places of highest exposure, on the rear seats.

7. For VLF magnetic fields (2-300 kHz), there was a regular fluctuation between approximately 0.6 and 12 mA/m (0.0075 – 0.15 mG) when the gasoline engine was engaged. Levels were 4-6 mA/m (0.05 – 0.075 mG) when operating on the electric motor alone.

8. There was a less than 0.3 mG, constant, approximately 6 Hz pulse coming from the bottom of the door frames, on the left side only.

9. There was an area of low-to-medium power density (depending on your point of view – it was less than 1 $\mu W/cm^2$) high frequencies (> 10 MHz), apparently originating from the smart key slot, on the dash to the right and below the steering wheel. It extended 14 or 15 inches toward the driver's seat, where it diminished into the low nanowatt range. The driver's knees and right hand would be exposed to it. It might affect Trifield readings, and may be similar to readings for smart-key systems in other types of vehicles.

10. There was an approximately 8 kV static electric field on the driver's door arm rest.

11. The NY Times article's statements about Trifields and other AC gaussmeters not measuring DC fields is misleading – that “the meter is set up to test alternating current fields, whereas the power moving to and from a hybrid vehicle's battery is direct current.” Direct current motors, when they're spinning, put out alternating fields as well as DC fields, which are detectable on an AC gaussmeter when their rpms are within the meter's frequency range. I'm not sure what the rpm ranges are on hybrid electric motors, but when testing it's important to test with a meter that at least goes into the low VLF range (2 kHz), and with a VLF meter as well.

12. Toyota's statement that the 50-60 Hz fields in the Prius are comparable to conventional gasoline-powered vehicles appears to be correct, but fields are higher at other extremely-low-frequencies on the back seats.

Recommendation for Prius owners is to provide some kind of comfortable elevation above the back seats for long trips, and avoid seating children in the back for very long unless they're in a car seat that significantly elevates them above the seat – preferably the center seat, which is already slightly above the side seats and safer from side impacts. It's also best to avoid hard acceleration. There's a general reverse correlation between fuel economy and magnetic field exposure – the higher the mpg at any moment (which can be constantly displayed on the center touch screen), the lower the magnetic fields.

There might also be less high-frequency exposure if the smart key were kept inserted in the slot on the dash while driving, instead of in a pocket or purse, so the system doesn't have to keep "looking for it," but this wasn't possible to determine during this testing, and it's not certain that the high frequencies around the smart key slot were from the smart key system – they didn't change when the key was inserted.