



## EMF Research News

### A Semiannual Report from EPRI's Electric and Magnetic Fields and Radio-Frequency Health Assessment and Safety Program

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**July 2012**

Dear Reader,

I am pleased to offer you the latest issue of our *EMF Research News*. In it you will find results of our most recent exposure measurement study of electric vehicles, and summaries of our recent publications on various topics ranging from a review of the stray voltage issue to potential effects of EMF on aquatic life. I hope you will find our newsletter informative and relevant to your needs.

Best regards,

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## Magnetic Fields Characterized in Electric Vehicles

As vehicles powered by electricity or a combination of electricity and gasoline become more popular, their owners may request information about passengers' potential exposure to magnetic fields. An EPRI [pilot study](#), published online by *Bioelectromagnetics* on April 24, 2012, offers preliminary information about magnetic fields in moving vehicles.

The study included 8 electric vehicles (7 cars and 1 truck) and 6 gas vehicles (4 cars and 2 trucks) manufactured between 2000 and 2009. As each vehicle drove a 10-mile course, magnetic field levels were measured every 4 seconds by EMDEX Lite broadband meters placed at 6 locations within each vehicle. The geometric mean of all magnetic field measurements was 0.095 microtesla for electric cars compared with 0.051 microtesla for gasoline-powered cars.

Referencing magnetic field personal exposure data taken in 218 residences studied in EPRI's Long-Term Wire Code Study (published in the *Journal of Exposure Analysis and Environmental Epidemiology* in 2002), the authors report that "magnetic fields in electric vehicles cover the same range as personal exposure levels within one's residence." They also note that "All fields measured in all vehicles were much less than the exposure limits published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the Institute of Electrical and Electronics Engineers (IEEE)." Study vehicles and technical support were provided by Southern California Edison.

## Stray Voltage and Its Impact on Dairy Cow Health and Milk Production

For more than 30 years, dairy farmers have dealt with the issue of cows encountering small stray voltages that could impact their health and milk production. It is important to clarify what stray voltage means in this context, so effective mitigations can be applied when necessary.

A cow's exposure to stray voltage occurs when it simultaneously contacts two grounded objects of differing voltage (for example, the milking machine and the milking parlor floor), causing current to flow through the animal's body. Some cows reportedly perceive current flow when the source is as low as 1 volt; 4 volts has been reported as a threshold for harmful effects. Although stray voltages often occur unexpectedly and are unwelcome, they result from the normal flow of current in ground paths.

EPRI's recent resource paper (EPRI [1025392](#), May 2012) clarifies how stray voltage develops during the normal operation of code-compliant systems for delivering and using electricity. This document discusses

- causes of electric current flow in ground paths,
- mechanisms whereby current flows cause a voltage difference between grounded objects,
- ways in which a cow may perceive these voltages, and
- measurement and mitigation methods.

## Underwater Power Cables—Potential EMF Effects on Aquatic Life

Marine and hydrokinetic energy projects are attractive because they convert energy from ocean tidal or wave action, or river currents, into electricity—while avoiding the adverse environmental impacts of dams and fossil fuel combustion. However, little research has addressed potential effects on aquatic life from exposure to electromagnetic fields (EMFs) produced by underwater power cables.

Proper cable installation can prevent electrical leakage but cannot completely contain the magnetic field, or the consequent induced electrical field, generated by a submerged cable. Keeping this fact in mind, EPRI reviewed the scientific literature to date (EPRI [1024943](#), March 2012), and concluded that "knowledge about EMFs emitted by submerged power cables is too variable and inconclusive to make an informed assessment of the effects on aquatic organisms." EPRI's review recommends studies

to characterize EMFs near underwater cables, as well as studies to describe the responses of nearby aquatic organisms exposed to those fields.

### **Managing Transmission Line Easements to Benefit Native Bees**

Native bees are essential to the U.S. agricultural economy because they pollinate crops. Power companies have the opportunity to manage vegetation in transmission rights-of-way (ROWs) to help sustain healthy bee populations.

Hallmarks of healthy bee populations include abundance, genetic diversity, normal larval development, and effective crop pollination. A recent report (EPRI [1023106](#), December 2011) offers preliminary results from an ongoing, quantitative investigation of ways in which vegetation management practices and transmission line EMF exposure may impact bee populations. EPRI is conducting this 3-year study at 95 ROW sites located in Maryland, Wisconsin, Oregon, and New Jersey. The sites represent rural, agricultural, and suburban areas, and contrast traditional vegetation management practices (mowing and mechanical removal) with integrated vegetation management (IVM)

(combining various practices to meet local needs). Observations of bees at study sites and nearby control sites from May through September 2011 suggest these preliminary conclusions:

- ROWs employing IVM yield greater bee abundance and genetic diversity than sites employing traditional mowing.
- EMF from transmission lines does not appear to decrease bee populations or interfere with foraging.
- Cavity-nesting bees prefer to build their nests in sites with dead wood, like those managed with IVM. Thus, balancing areas with dead wood, low litter content, and bare sandy soil will promote a diverse bee community composed of cavity and ground nesters.
- Bees do not move into inappropriate habitat, such as nearby forest.

Field observations and species identification of 7500 captured bees will continue in 2012. This research benefits from cooperation among EPRI member companies, the U.S. Geological Survey, U.S. Forest Service, U.S. Fish and Wildlife Service, and U.S. Army Corps of Engineers.

### **Distortions, Harmonics, and Noise—Causes of Electric Power System Problems**

The electric power system has always experienced waveform distortion, harmonics, and electromagnetic noise on a regular basis. However, sources of these unintended factors are proliferating, as residential customers install switching power supplies, compact fluorescent lamps, light dimmers, and variable speed motor drives. Operation of these devices can cause transformer and machinery overheating, telephone and radio interference, and other problems that demand engineering solutions.

EPRI's new resource paper (EPRI [1025390](#), May 2012) introduces some causes of unintended factors that exist on the electric power system and provides clarification of the physical phenomena.

## Public Information Brochure Explains EMF

Since we rely on electricity to support modern life, it is important to ask whether exposure to electric and magnetic fields (EMF) is safe or whether it can have potential adverse effects. Thousands of scientific studies over the past 30 years have addressed this question, producing a large amount of scientific information.

Although no direct link between magnetic fields and adverse health effects has been confirmed, there remains a consistently observed association between residential magnetic field exposure and childhood leukemia reported in epidemiologic studies. However, this association is not supported by results of laboratory animal studies, and no generally accepted biophysical mechanism exists to explain a potential carcinogenic effect.

EPRI's 22-page brochure, "EMF and Your Health" (EPRI [1023105](#), December 2011), describes the physical nature of electric and magnetic fields, the health research and its findings, the range of everyday exposures to EMF, and the conclusions reached by scientific panels and policymakers.

## EPRI Comments on Two Smart Meter Memoranda

In January 2012, the Santa Cruz California County Health Officer and the American Academy of Environmental Medicine (AAEM) issued separate memoranda supporting the view that radio-frequency (RF) electromagnetic fields emitted from smart meters pose a health risk. Both memoranda assert that the 1997 Federal Communications Commission (FCC) rule setting enforceable limits on human RF exposure protects only against adverse thermal effects, and does not address non-thermal effects.

In its comments (EPRI [1024952](#), February 2012), EPRI offers additional perspectives on the issues raised in these memoranda.

- The AAEM states that "[e]xisting safety limits for pulsed RF were termed 'not protective of public health' by the Radiofrequency Interagency Working Group (RFAIWG), whose members include the FCC, Food and Drug Administration (FDA), Occupational Safety and Health Administration, and Environmental Protection Agency. Close examination of documents reveals that the RFAIWG was simply raising the issue of pulsed RF exposure limits for consideration by the Institute of Electrical and Electronics

Engineers (IEEE) Risk Assessment Work Group, not asserting that the FCC's limits were not protective. With respect to pulsed RF fields, IEEE responded that "There are no reliable studies that provide convincing evidence of adverse, nonthermal effects, occurring at exposure levels below the current guidelines."

All of the RFAIWG member agencies had previously endorsed the FCC's 1997 rule based on the scientific conclusion that the only *established* effects were those associated with tissue heating. There were no confirmed adverse effects below an RF exposure threshold that raised body temperature by about 1 degree centigrade. Since 1997, the expanding body of scientific evidence continues to support the basic conclusions reached by the FCC in formulating its original rule.

- The AAEM also states that "the US [National Institute of Environmental Health Sciences] NIEHS National Toxicology Program in 1999 cited radiofrequency radiation as a potential carcinogen." According to EPRI, the FDA nominated RF to the National Toxicology Program (NTP) as an exposure to be tested in a long-term cancer study in animals (now in progress).

But the FDA’s nomination offered no conclusion regarding RF carcinogenicity.

In 2011, largely on the basis of studies addressing RF exposures from cellular telephones, the International Agency for Research on Cancer (IARC) classified RF electromagnetic fields a “possible” (Group 2B) carcinogen—meaning that existing research information is “limited” and leaves uncertainties that further study could resolve. This designation falls below the threshold for IARC to conclude that RF is “probably” carcinogenic (Group 2A).

- The Santa Cruz memorandum states that “...SmartMeters emit frequencies almost continuously... at 100% of a duty cycle ...and therefore it should not be possible to state that SmartMeters do not exceed the time-averaged exposure limit.” (A measured RF field is multiplied by the duty cycle to derive an average exposure level.) However, EPRI-sponsored research has shown that only 0.2% of 88,296 meters in the Pacific Gas and Electric service territory transmitted for 1% or more of the time (more than 14 minutes per day).

In EPRI’s studies, exposure levels from smart meters installed in California service territories are very low because the meters transmit at power levels no greater than about 1 watt, the same power used by a small flashlight bulb. The RF fields smart meters emit fall well below exposure limits published by the FCC, International Commission on Non-Ionizing Radiation

Protection (ICNIRP), and IEEE—even very close to the meter face. These published exposure limits are the product of careful and thorough evaluations of the scientific literature at all levels of exposure (above and below thermal thresholds).

### **Interaction Between AM Radio Broadcast Antennas and Overhead Power Lines**

Overhead power lines can distort the signal pattern of an amplitude-modulated (AM) radio broadcast station antenna, which in certain cases can place the station in violation of its Federal Communications Commission license. Thus, it is essential to understand this phenomenon—also referred to as re-radiation—and mitigate it when necessary.

Distortion of a radio signal pattern is maximized when dimensions of nearby metallic structures (such as power lines) cause those structures to resonate at the radio signal’s frequency. The signal radiated back by a power line or other structure may alter the radio signal pattern in a noncompliant direction.

These interactions are described in EPRI’s resource paper (EPRI [1025391](#), May 2012), which presents

- principles of broadcast antennas,
- the basic physics of re-radiation,
- analysis methods,
- situations where re-radiation is of most concern, and
- applicable mitigation methods.

### **EPRI Staff Presents at Bioelectromagnetics Society 34th Annual Meeting**

The Bioelectromagnetics Society held its 34th Annual Meeting June 17–22, 2012, in Brisbane, Australia. During the meeting’s “Policy and ELF Epidemiology” session, Dr. Robert Kavet of EPRI provided a summary of his analysis of the association between residential exposures to contact voltage and magnetic fields. He also co-authored a paper—presented by a colleague—that reviewed the background and rationale for EMF exposure standards and guidelines. In a satellite session organized by the Australian Electricity Network Association, Dr. Gabor Mezei was invited to give an overview of the research work conducted by the EMF Health Assessment Program in the Environment Sector of the Electric Power Research Institute.

## Upcoming Events

### 2012 EMF and RF Health Assessment and Safety Scientific Advisory Committee Meeting

August 13–14, Sonoma, CA. The program's external Scientific Advisory Committee is a multidisciplinary group of eminent scientists and engineering experts who meet annually with EPRI staff to review areas of emphasis in the current research program and to suggest new research directions in epidemiology, engineering, laboratory medicine, and occupational exposure assessment.

### 2012 EPRI Fall Environment Program Advisory Meetings

September 11–12, Milwaukee, WI. EPRI's Environment Program Committees help define and prioritize projects and activities in a manner consistent with EPRI's public benefit mission and the needs of the industry, decision-makers, and consumers. These meetings are also excellent opportunities to exchange information and experience, and learn about new EPRI research offerings. More information is available to Environment program funders at the [event website](#).

### 7th International Workshop on Biological Effects of Electromagnetic Fields

October 8–12, Malta. This forum for researchers with cross-disciplinary interests aims to cover all areas of EMF—from basic research, experimental results, modeling and simulation, to management and regulatory policies. More information is available at the [event website](#).

### EEI/NREC Utility Siting Workshop

October 21–24, Madison, WI. This workshop, presented by the Edison Electric Institute (EEI) and the National Rural Electric Cooperative Association (NREC), will cover topics such as EMF, routing and permitting, and public involvement and social networking. More information is available to EEI and NREC members at the [event website](#).

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